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ENGINEERING FLIGHT EVALUATION OF UH-2B ARMED HELICOPTER

FINAL REPORT

Mr. John N. Johnson
Project Engineer

Mr. William A. Anderson
Project Pilot

MARCH 1966

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ENGINEERING FLIGHT EVALUATION OF UH-2B ARMED HELICOPTER

RDT&E PROJECT NO. 1F141807D174

(USATECOM PROJECT NO. 4-6-0300-01)
(USAAVNTA PROJECT NO. 65-31)

FINAL REPORT

JOHN N. JOHNSON
PROJECT ENGINEER

WILLIAM A. ANDERSON
PROJECT PILOT

MARCH 1966

U. S. ARMY AVIATION TEST ACTIVITY

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ABSTRACT

This report presents the results of an engineering flight evaluation conducted to determine the technical engineering flight characteristics of the armed UH-2B helicopter. The evaluation was conducted by the U. S. Army Aviation Test Activity (USAAVNTA), Edwards Air Force Base, California. Tests were conducted at Edwards Air Force Base and Bakersfield, California. Twenty-four productive flight hours were flown in the UH-2B, Bu No. 152202, during the period 17 November to 2 December 1965. The USAAVNTA was assigned responsibility for preparing the test plan, executing the test and preparing the test report.

The maneuvering characteristics of the helicopter were stressed during the evaluation. Tests conducted included steady turns, pull-ups, accelerations and decelerations, tear-drop turns, and turn reversals. The maneuvering characteristics during an abrupt pull-up were undesirable. A negative maneuvering stability gradient occurred following a pull-up at high airspeeds and heavy gross weights. This apparently occurred when the helicopter encountered blade stall. Directional control step inputs caused a nose-down pitch with right pedal and a small nose-up pitch with left pedal. This characteristic was undesirable for weapons firing.

SECTION 1 - GENERAL

1. BACKGROUND

The Department of the Army directed the U. S. Army Materiel Command (USAMC) to conduct an expedited flight test evaluation of a selected group of armed helicopters. In messages, 23 October and 28 October 1965 (References a and b, Section 2, Appendix II), USAMC assigned this program to the U. S. Army Test and Evaluation Command (USATECOM) for testing by the U. S. Army Aviation Test Activity (USAAVNTA), under the technical direction of an AMC appointed representative who had full responsibility for the conduct of the flight test program. The Plan of Test of the Armed Helicopters (Reference c) was submitted by USAAVNTA 28 October 1965 and approved 8 November 1965. The test program was conducted at Edwards Air Force Base, California, from 17 November to 1 December 1965. An interim summary report of the combined armed helicopter test results (Reference d) was submitted by USAAVNTA on 6 December 1965 to the Chairman, Improved Armed Helicopter Evaluation Group, Hq, USAMC. This report presents the final results of the engineering flight evaluation of the armed UH-2B helicopter.

2. DESCRIPTION OF MATERIEL

2.1 BASIC UH-2B HELICOPTER

The UH-2B helicopter, Bu No. 152202, was provided for this evaluation through the cooperation of the U. S. Navy. The helicopter has a single main rotor and an antitorque tail rotor. The helicopter is powered by a T58-GE-8 turboshaft engine. The engine is mounted above the cabin behind the main rotor mast. The four-bladed main rotor is driven through the main gear box which is mounted in front of the engine. Cyclic and collective pitch controls are obtained through blade servo flaps mounted on the main rotor blades. Aerodynamic action of the flaps stabilizes and changes the pitch of the main rotor blades, which are otherwise unrestrained in feather, in response to the pilot's operation of the cyclic and collective controls. An in-flight blade tracking system automatically adjusts the tip path of the main rotor blades in response to 1-per-rev out-of-track vibration sensor signals. The aircraft is equipped with automatic stabilization equipment (ASE). This equipment, however, was not used during this evaluation. A yaw rate damper was installed in the aircraft and was used for all stability and control and maneuverability tests. The aircraft has a retractable main landing gear and a full-swivel non-retractable tail wheel. The principal dimensions and general data are as follows:

Maximum Gross Weight	10,000 lb
Maximum Forward Center of Gravity (C.G.)	Sta. 158
Maximum Aft C.G.	Sta. 173

Main Rotor	
100% RPM	277 RPM
Disc Area	1520.5 sq ft
Total Blade Area (Including Servo Flaps)	134.2 sq ft
Blade Diameter	44.0 ft
Blade Chord	20.0 in
Solidity Ratio	.0965
Shaft Angle-From Vertical Forward	6 deg
Tail Rotor	
Disc Area	50.4 sq ft
Blade Area	7.0 sq ft
Blade Diameter	4.0 ft

2.2 UH-2B ARMAMENT

For the purpose of this evaluation the UH-2B was configured with a modified TAT 141 and two LAU 3A/A 19-round 2.75-inch rocket pods. The TAT 141 consists of an M-5 grenade launcher and an XM-134 7.62 mini gun. The M-5 grenade launcher, however, was not installed for this evaluation; and instead the test airspeed boom, which was considered to be equivalent in drag area to the launcher, was used. The modified TAT 141 was mounted in the nose of the aircraft and the rocket pods were mounted under stub wings located on the side of the fuselage near the cabin area.

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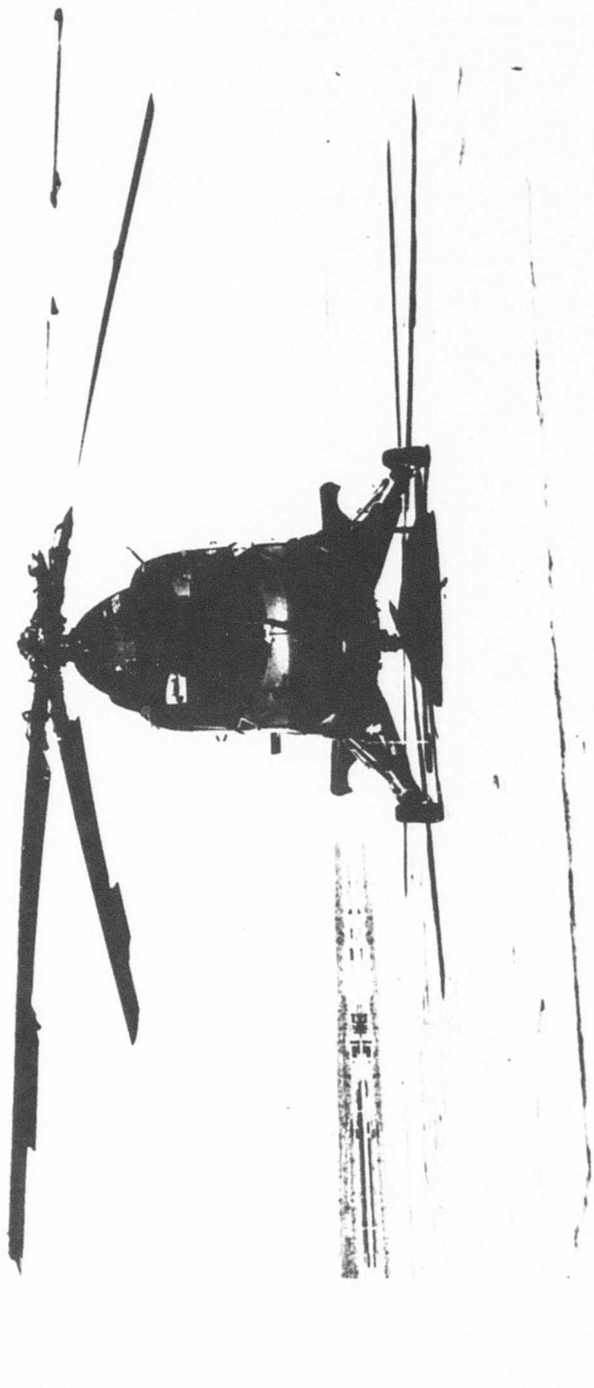


3. OBJECTIVES

The objective of this test was to determine the technical engineering flight test characteristics of the UH-2B in an armed configuration.

4. SUMMARY OF RESULTS

4.1 COCKPIT

The pilot station was comfortable. The seat and pedal adjustments were large enough to accommodate a variety of pilot dimensions. Both collective and cyclic controls were comfortable to operate throughout their range of travel. All other controls necessary to the mission were within easy reach. Visibility out of the cockpit was somewhat restricted for low-level maneuvering, particularly for steep left turns, during which the overhead console obscured a large area of the view. Vibration levels were generally low and caused no fatigue or distraction.

4.2 ENGINE START

The engine start procedure was quick and simple. Starts could be made with internal or external power. The engine was started with the rotor brake ON. With a fully charged battery the engine accelerated to ground-idle in less than 20 seconds, after which the rotor brake could be released. Subsequent engine and rotor acceleration characteristics were good. Ten seconds after release of the rotor brake, 100-percent rotor speed (277 RPM) could be reached. The yaw damper could be engaged approximately 2 minutes after rotor start. All checks could be carried out rapidly and short "scramble" times were possible. From crew entry to lift-off, a minimum elapsed time of 2 minutes could readily be achieved.

4.3 TAXI

Taxiing was conducted using 90- to 100-percent rotor RPM. A small amount of collective pitch usually was required to initiate the taxi. The aircraft could easily be taxied rearward with the tail wheel locked. During taxi forward small changes in direction (2 to 3 degrees) could be made with the tail wheel locked. The toe-operated wheel brakes were very effective. With the tail wheel unlocked, very tight ground maneuvering was possible and directional response to pedal was quick and effective. The overhead tail-wheel locking lever was sometimes awkward to operate. To release the locking pin required some pedal rocking unless the tail wheel was trailing symmetrically.

4.4 TAKEOFF, HOVER AND LANDING

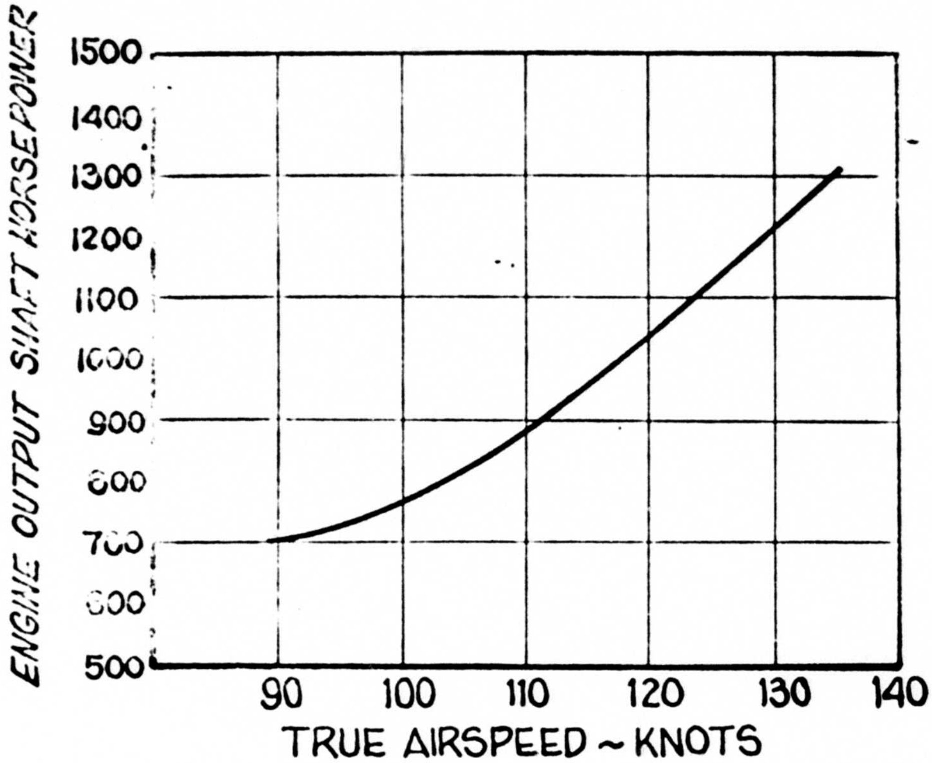
Handling qualities and performance capabilities of the aircraft during hover, takeoff and landing were not quantitatively evaluated. Although there were no unusual characteristics, the following qualitative handling qualities were noted:

a. Vertical lift-off to a hover was normal and presented no unusual control problems. Hovering attitude was essentially level. Stability during hover was satisfactory for a single-rotor helicopter not employing stability augmentation. Aircraft response to cyclic, collective and pedal controls was satisfactory. A running takeoff was usually made as this was the quickest and easiest method of attaining cruise speed or climb speed.

b. The landing gear suspension was stiff and vertical landings were usually accompanied by some skipping and bouncing. Run-on landings were usually made. In these landings, the tail wheel was allowed to touch the ground during the flare before the main wheels were lowered.

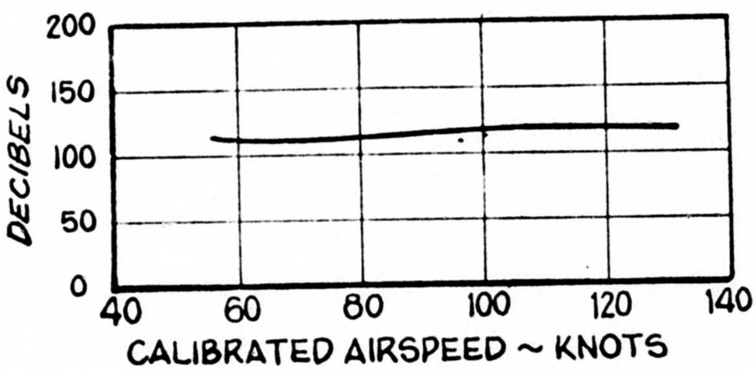
4.5 LEVEL FLIGHT

4.5.1 Level flight tests were conducted at density altitudes ranging from 800 feet to 6350 feet and gross weights ranging from 7600 pounds to 9690 pounds. Individual test results are presented in Section 2, Appendix I, Figures 4 through 11 and summarized in Figures 2 and 3. Limited range performance with the simulated TAT 141 and two LAU 3A/A 19-round rocket pods without nose cones is presented in Figure 1. Rotor speeds of 277 (100 percent) and 266 (96 percent) were used for the tests conducted. There were no unusual level flight characteristics up to the maximum airspeeds tested. Level flight performance tests were also conducted to determine the effects of the addition of the rocket-pod nose cones and the removal of the left cabin door on power required, true airspeed and equivalent flat plate area. At a gross weight of 9300 pounds and 130 knots true airspeed (KTAS) reduced to sea-level standard-day conditions, a decrease in equivalent flat plate area of 1.2 square feet was realized with the addition of the rocket pod nose cones. At these conditions this was equivalent to an increase of approximately 3 KTAS, or a reduction in power required of 25 shaft horsepower (SHP). Under the same conditions, with the removal of the left cabin door, an increase of approximately 4.3 square feet in the flat plate area was realized. This was equivalent to a decrease of approximately 5 knots, or an increase of 90 SHP required. The following graph shows engine output shaft horsepower versus true airspeed at 9300 pounds gross weight, and 100-percent rotor RPM, sea-level standard day:



4.5.2 Vertical and lateral vibration characteristics were measured at the pilot's seat and in the cargo compartment directly below the transmission. Vibration data is presented in Figures 14 through 16. At gross weights of 8000 pounds to 9720 pounds, the UH-2B exhibited low vibration characteristics during level flight above 70 KCAS at 100-percent rotor speed. These characteristics were within the limits of Paragraph 3.7, MIL-H-8501A (Reference e). The 4-per-rev vertical single-amplitude vibration accelerations measured in the cabin area, however, did exceed MIL-H-8501A between 50 - 70 KCAS above 9670 pounds gross weight. Vibration data was not recorded below approximately 50 KCAS. The aircraft battery was mounted as a 4-per-rev vibration absorber and was tuned at approximately 100-percent rotor speed. At lower rotor speeds, a marked increase in the 4-per-rev vibration was noticed. The automatic blade tracking system provided very good 1-per-rev rotor tracking in level flight but was automatically disengaged during maneuvering flight above .15 g. Following any severe maneuvers, a period of several seconds was required for any resulting out-of-track condition to be corrected. One-g blade stall was characterized by heavy 1-per-rev vibration and a slight buildup in 4-per-rev vibration. The latter warning was reduced by the vibration absorber, which consequently reduced blade stall warning. During maneuvers there was inadequate blade stall warning.

4.5.3 Sound measurements were obtained at the copilot's head position using U. S. Air Force Bureau of Standards calibrated equipment. The cockpit noise level was moderately high, dominated by a high-pitched transmission whine. It should be noted, however, that all soundproofing had been removed. As shown in the following figure, in level flight at an average gross weight of 8130 pounds, recorded noise levels varied from a low of 111 decibels at 70 knots calibrated airspeed (KCAS) to a high of 118.5 decibels at 132 KCAS. The noise never reached uncomfortable or distracting proportions. Test data is presented in Figure 17.

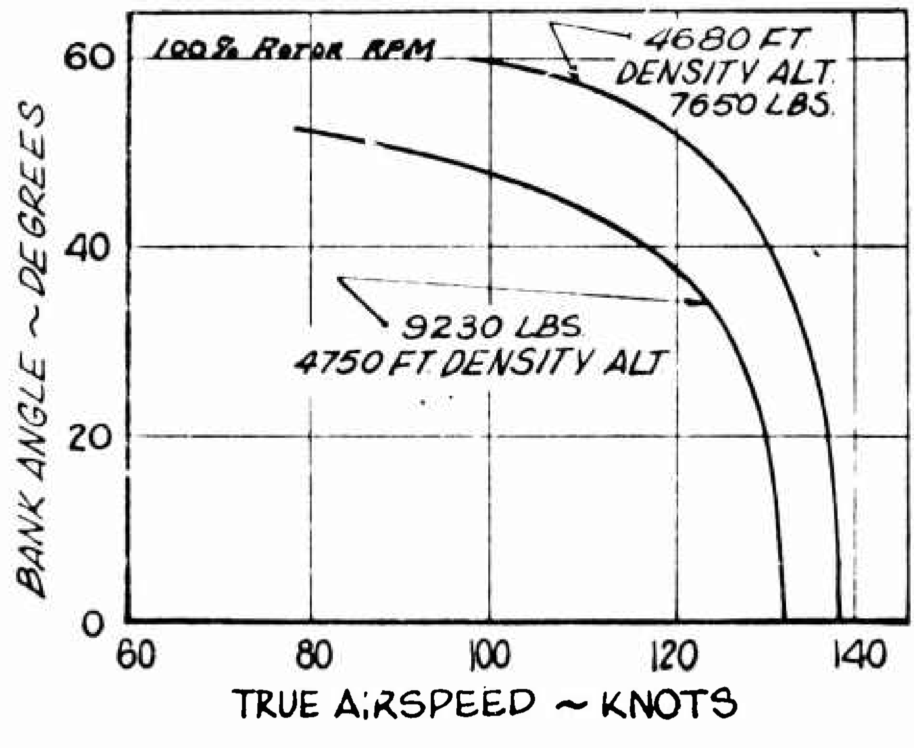


4.6 STABILIZED TURNING PERFORMANCE

4.6.1 Stabilized turning performance data was collected using two methods. The first method was to establish a trim speed at the test altitude and record the power required. Various stabilized bank angles were established while holding trim power and altitude constant and the resulting stabilized airspeeds were recorded. Bank angle was increased until altitude could no longer be maintained. The second method used was to perform the same maneuver maintaining the desired trim speed and altitude and adjusting power and bank angle as required. This maneuver was performed using various trim speeds up to maximum airspeeds.

4.6.2 Stabilized level turning performance tests using the first method proved to be impractical in the UH-2B because of difficulty in maintaining trim power due to the fuel control governor inputs as rotor loading varied. The second method was more suitable. The general results and limiting factors obtained using this method are presented in the next paragraph.

4.6.3 In all cases, at the maximum bank angles, power available was the limiting factor, rather than rotor blade stall. Four trim speeds were flown and each speed was maintained at increased bank angles until full power was being used. Aft stick forces were high for a helicopter but provided excellent stick-force-per-g characteristics for level flight stabilized high-rate turns. Stabilized turning performance is presented in Figures 18 and 19 and compared to a 1-g level flight performance at the same conditions. The following graph presents the maximum sustained bank angle, as limited by power available at mid C.G., and 7650 pounds and 9230 pounds gross weight and 4680 feet and 4750 feet density altitude respectively.

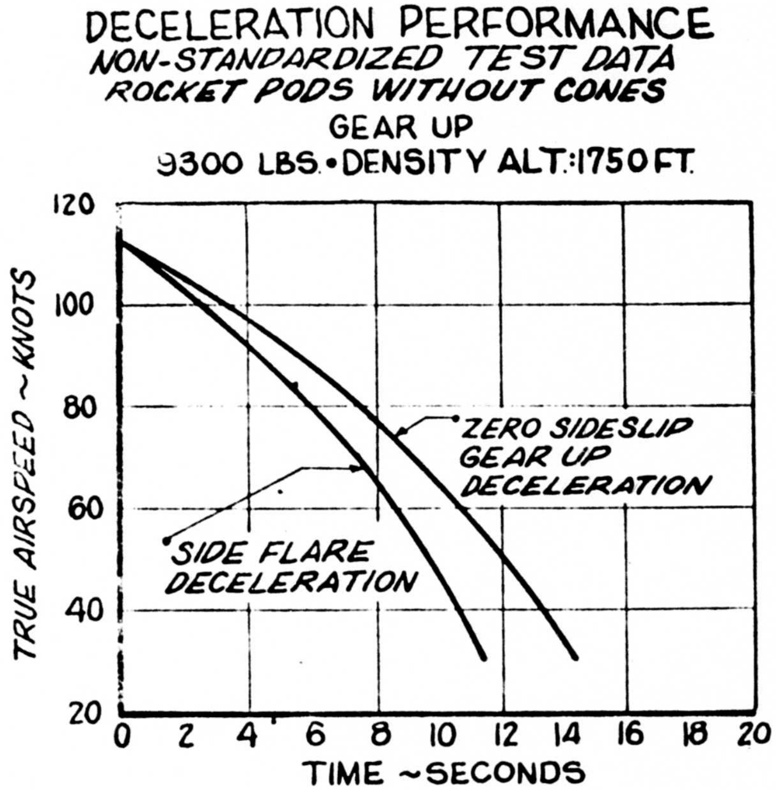


4.7 LEVEL ACCELERATIONS

Level flight accelerations were conducted at 7600 pounds and 9300 pounds at density altitudes of 3090 feet and 1750 feet respectively. Level accelerations were initiated from stabilized flight at the speed near minimum power required, approximately 50 KCAS. Collective pitch was set to obtain maximum power available. Altitude was maintained with cyclic pitch and the aircraft was allowed to accelerate to near maximum airspeed. Selection of maximum power was achieved by increasing collective pitch as rapidly as possible to a value near maximum power. When engine speed and rotor speed transients were stabilized, an adjustment to maximum power was made. A coordinated nose-down attitude change accompanied the power increase to maintain constant height. The aircraft was easy to control during acceleration from 50 KCAS to maximum airspeed. During the acceleration, collective pitch had to be continually increased to maintain full power. Level flight acceleration data is presented in terms of energy per unit time (foot-pounds/second-dE/dt) versus true airspeed in Figures 21 and 22 and compared in Figure 20.

4.8 LEVEL DECELERATIONS

Level decelerations were accomplished at a test gross weight of approximately 9300 pounds from 112 KTAS to approximately 30 knots by reducing power to minimum practical and maintaining constant altitude. There were no limiting factors for this maneuver apart from the inherent drag characteristics and energy absorption capability of the rotor. As collective was reduced to minimum, the twist grip was closed to idle; this gave an 8-percent engine rotor needle split. Rotor speed was maintained between 95-percent and 100-percent RPM. Nose-up attitude was increased to maintain height. At about 30 KCAS the twist grip was opened fully and power was increased to assist deceleration and establish a hover. The engine response was very good and twist grip control was precise and rapid. The aircraft displayed good flying qualities throughout this maneuver, although the nose-down trim change as collective was reduced was greater than allowed in Paragraphs 3.2.10.2 and 3.5.5.1, MIL-H-8501A (Reference e). Adequate control power, however, existed to compensate for this. The following plot of the true airspeed versus time presents the general deceleration performance at 9300 pounds and 1750 feet density altitude, at test day conditions.



As can be seen, a slight time advantage is gained using the side flare although this is not a recommended maneuver. This is discussed in Paragraph 4.9.

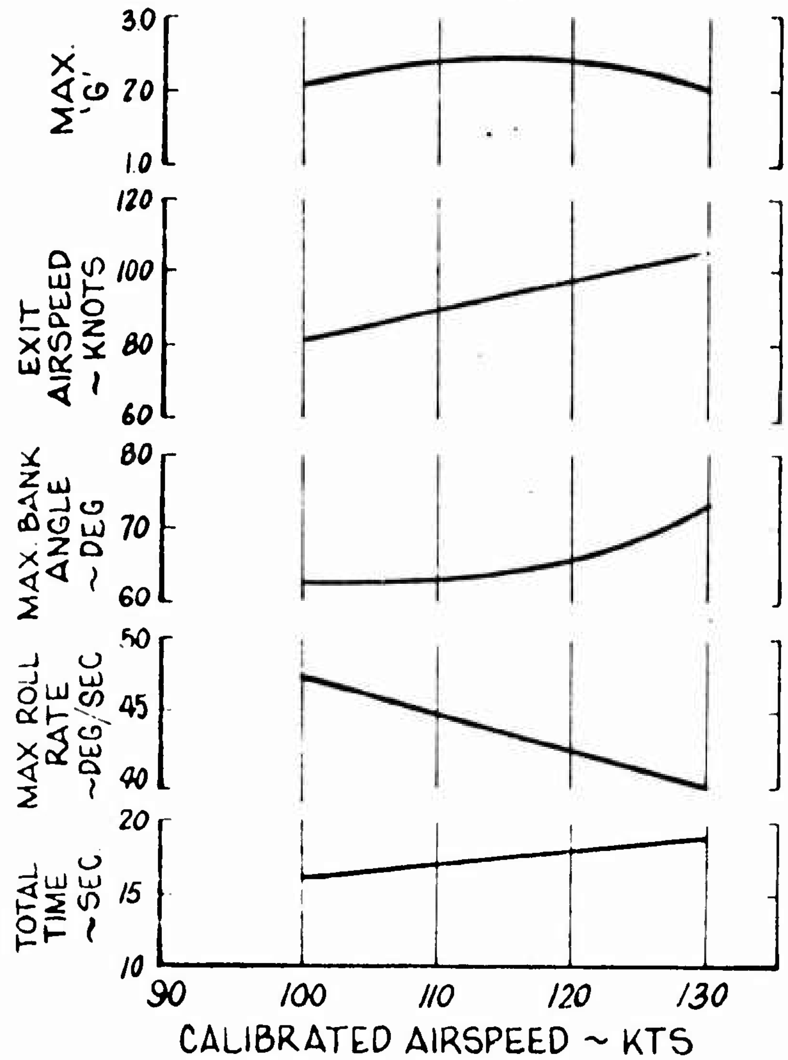
4.9 LEVEL DECELERATION SIDE FLARES

Side flares were accomplished at a test gross weight of approximately 9300 pounds from various entry airspeeds up to maximum obtainable airspeed. The technique used to execute this maneuver was to maintain a straight path over the ground, decelerate and come to a hover with the aircraft heading perpendicular to original flight path. In order to accomplish this and remain within the sideslip envelope of the UH-2B aircraft, the initial bank was in the direction of flight until the flight path speed was dissipated enough to obtain a sideslip angle of 90 degrees. At this point a sharp bank reversal was made and a hover was established without a change in altitude. This maneuver was highly impractical because it was extremely difficult to remain within the operational sideslip envelope of the aircraft. Limiting factors for the UH-2B,or any other helicopter, were primarily those of the degree of difficulty in execution and the extremely uncoordinated nature of the maneuver. To maintain a straight path over the ground and to present maximum drag for deceleration, a severe sideslip had to be initiated simultaneously with a zero power deceleration (as in straight decelerations). Strong positive dihedral effect and directional stability at high speed necessitated large out-of-trim forces and caused extreme discomfort during the initial sideslip. The UH-2B had a large sideslip envelope and decelerated rapidly during this maneuver. The achievement of minimum stopping distances was limited only by pilot skill and persistence. Distance and time increased as a function of increased airspeed, and in general an approximately 20-percent reduction in stopping time and distance could be obtained using this method as compared to time and distance required to stop during the straight deceleration. Side flares to the right were less effective than to the left due to reduced rudder control power available needed to obtain high sideslip angles. Under conditions in which marginal power reserve for hovering was available the completion of the maneuver would have required more transient power than available. Under these conditions the maneuver would be impractical. The plot presented at test day conditions in Paragraph 4.8 shows the reduction in time to perform a side flare deceleration as compared to a zero sideslip deceleration, with an entry true airspeed of 112 knots.

4.10 TURN REVERSALS

4.10.1 Turn reversals presented in Figure 23 were accomplished at 8800 pounds gross weight and at various airspeeds up to maximum airspeeds. The technique used was to stabilize on power, airspeed, and altitude, and rapidly displace the controls to obtain maximum useable roll rate. A maximum-effort level turn was held for 90 degrees and rapidly reversed for another 90 degrees. The maneuvering was terminated wings level on original heading. Trim power and altitude were held constant throughout the maneuver.

4.10.2 The turn reversal maneuvers were entered at calibrated airspeeds of 101, 119, 127 and 128.5 knots. A smoothly coordinated roll and aft stick displacement were employed to initiate the turn. Ground references were used for heading control. Maximum load factor as limited by power and/or blade stall was used. Maximum comfortable roll rates of 47 degrees/second were obtained at 100 KCAS and reduced to 40 degrees/second at V_{max}. Blade stall during right rolls and during the turns was the main limiting factor at V_{max}. Power available was the limiting factor at 101 and 119 KCAS. If more power were available during the turn at 101 KCAS and 119 KCAS, reduction in turning radius and in total time would be achieved. The following graph summarizes the turn reversal performance at test day conditions of 8800 pounds gross weight and 2850 feet density altitude.



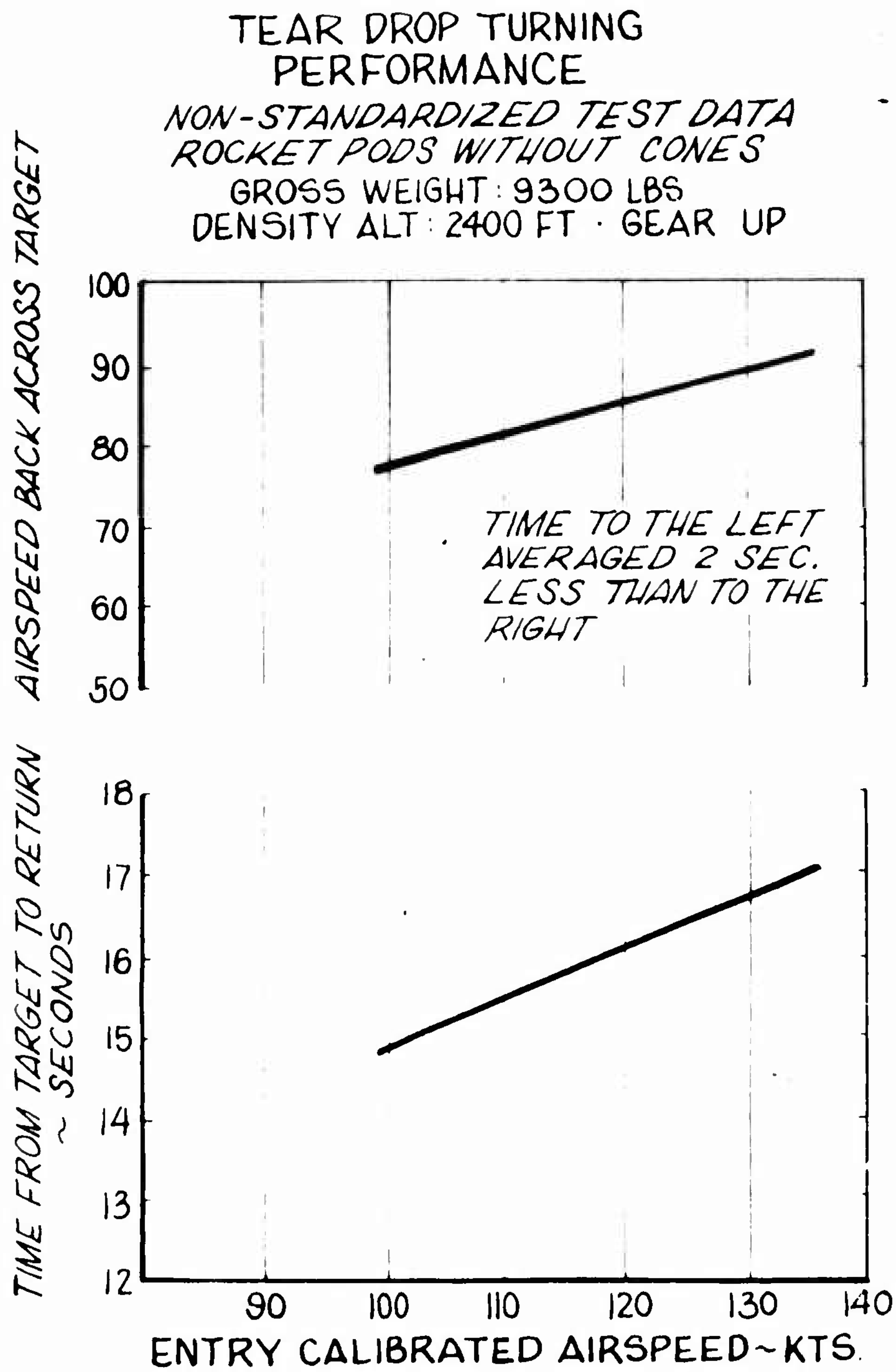
As can be seen from the presentation, the time required to complete the maneuver decreased with entry airspeed in the range of speeds tested.

4.11 TEAR DROP TURNS

4.11.1 This maneuver consisted of passing over a pre-selected point on the ground, making a steep turn and returning over that spot in minimum time, maintaining a constant altitude. This maneuver was accomplished using various entry speeds up to maximum level flight speed. The entry calibrated airspeeds selected were 100, 120 and 133 knots. Optimum techniques for obtaining the maximum rate and minimum radius turns at each entry speed were established prior to taking final test data. The following limitations were applicable during the maneuver:

Load Factor	3 g
Rotor Speed	96% - 100%
Bank Angle	No limit
Torque	No limit
Maximum Engine Speed	102%
Blade Stall	1/rev onset

4.11.2 As can be seen in the accompanying graph presented at test day conditions, as airspeed was decreased, time to complete the maneuver was also decreased within the speed range tested. Speeds at entry in excess of 100 KCAS were, therefore, reduced as quickly as possible to 100 knots during the initial roll after crossing the target. This was accomplished by reducing the collective pitch several inches and increasing load factor as the bank angle increased. At 100 KCAS, full power was applied as indicated by 102-percent engine speed and 1-percent rotor bleed; and maximum load factor was applied as limited by blade stall onset. Bank angle was adjusted to maintain constant height above the ground. As the target came back into view, bank angle was reduced and maximum power was maintained to achieve the shortest flight path back to the target.


TEAR DROP TURNING
PERFORMANCE
NON-STANDARDIZED TEST DATA
ROCKET PODS WITHOUT CONES
GROSS WEIGHT: 9300 LBS
DENSITY ALT: 2400 FT · GEAR UP
AIRSPEED BACK ACROSS TARGET
100
90
80
70
60
50
TIME TO THE LEFT AVERAGED 2 SEC. LESS THAN TO THE RIGHT
TIME FROM TARGET TO RETURN ~ SECONDS
18
17
16
15
14
13
12
90
100
110
120
130
140
ENTRY CALIBRATED AIRSPEED ~ KTS.

4.11.3 Peak roll rates of approximately 40 degrees/second and maximum bank angles between 70 degrees and 80 degrees were used on entry. Load factor (g) was held between 2.3 and 2.7 g. The time to return to target depended to a great extent upon consistency of pilot technique but, in general, varied from 15 seconds at 100 KCAS entry speed to 17 seconds at 133 KCAS entry speed. Blade stall on the UH-2B was the main limiting factor in this type of maneuver, particularly at high gross weight. During the maximum g portion of the turn, there was very little warning of the onset of blade stall and, in spite of attempts to avoid it, blade stall was reached on almost every occasion at 9300 pounds. Blade stall on the UH-2B was characterized by heavy 1-per-rev vibration, longitudinal pitch-up, and increased 4-per-rev vibration. Once encountered, blade stall was self sustaining and required positive correction by reducing power and decreasing load factor (applying forward stick). A positive aft stick force of approximately 10 pounds was required to hold 2.8 g and a relaxation of this force aided in the recovery from blade stall. It is stressed that the ease of reaching blade stall and lack of stall warning are very undesirable features in the UH-2B helicopter. The maximum-rate, minimum-radius turn maneuver, however, was not the worst case with respect to maneuvering stability. The stability characteristics during diving pull-outs are discussed in Paragraph 4.13.4, MANEUVERING STABILITY. Blade stall was also induced by large roll demands to the right during the entry and exit rolls of the tear drop. A reduction in lateral cyclic control input was required to recover from the blade stall.

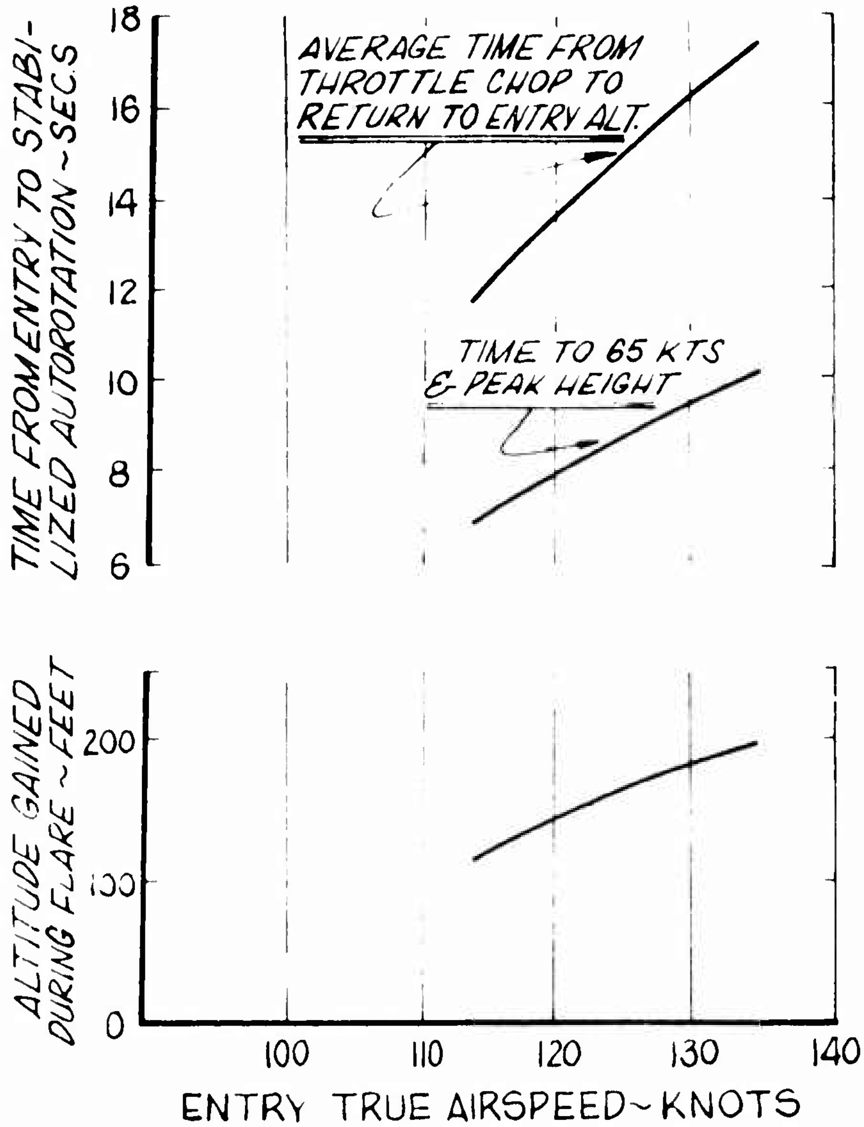
4.12 AUTOROTATIONAL ENTRIES

4.12.1 Level flight autorotational entries were conducted at a test gross weight of 9300 pounds at various airspeeds up to maximum airspeed by simulating total power failure. A 1-second time delay was used during this maneuver; i.e., the procedure was to close the throttle, hold all controls fixed for 1 second, then initiate recovery to attain best autorotative airspeed in minimum time.

4.12.2 The technique for the UH-2B was critical with regard to maximum height gain after a 1-second delay. If the collective was lowered fully at the same time the flare was initiated, i.e., after 1 second, only 75 to 100 feet were gained at an entry speed of 130 KCAS. If collective was held fixed or reduced only slightly after the 1-second delay and a rapid flare was made, nearly 200 feet of altitude were gained.

4.12.3 Rotor decay following power loss dictated the length of time that the collective could be held up during the flare and, therefore, the height gained. When rotor RPM had decayed to 90 percent, collective was reduced to maintain at least this value. At the peak of the height gain, the aircraft speed was nearly down to best autorotational speed. The following graph is a summary of autorotational entry test day data for the UH-2B at approximately 9300 pounds gross weight and 2400 feet density altitude.

AUTOROTATIONAL ENTRY
NON-STANDARDIZED TEST DATA
GEAR UP UNTIL 65 KTS REACHED
ROCKET PODS WITHOUT CONES
1 SECOND DELAY
GROSS WT: 9300 LBS / DENSITY ALT.: 2400 FT.



4.13 STABILITY AND CONTROL

4.13.1 STATIC LONGITUDINAL SPEED STABILITY

Collective-fixed static longitudinal speed stability tests were conducted at calibrated airspeeds of 61, 100 and 131 knots at 9000 pounds gross weight and density altitude of 3500 feet. Test data presented in Figure 31 shows the static longitudinal stability about trim versus calibrated airspeed to be slightly positive at 60 and 100 KCAS, becoming neutral at 130 KCAS. The control position trim curves in Figures 32 and 33 show that the trimmed longitudinal control position was positive up to nearly maximum calibrated airspeed, then became neutral for 277 rotor RPM and negative for 268 rotor RPM. This condition existed at conditions tested between 7600 and 9690 pounds gross weight, 4000 feet to 6350 feet density altitude at an approximately mid C.G. The "bob weight" in the longitudinal control system was noticeable in rough air since it applied a forward or aft stick force as a function of positive or negative normal acceleration. If the pilot allowed the stick to move, the "bob weight" corrected for gusts quite well. A large longitudinal trim change resulted from changes in collective position which, although in excess of requirements of paragraph 3.5.5.1, MIL-H-8501A (Reference e), were partly compensated for by the "bob weight."

4.13.2 STATIC LATERAL DIRECTIONAL STABILITY

Static lateral directional stability tests were conducted at calibrated airspeeds of 50, 100 and 127 knots and density altitudes of 3800 and 3900 feet. A rotor speed of 277 RPM was used at an approximately mid C.G. Test results, presented in Figures 34 through 36, show that the static lateral directional stability was strongly positive but that a nonsymmetrical longitudinal trim change accompanied the sideslip. Under transient conditions the "bob weight" assisted in compensating for this characteristic.

4.13.3 CONTROLLABILITY

4.13.3.1 Roll response characteristics, presented in Figures 37 through 39 with a time history of a left lateral step in Figure 40, were investigated at calibrated airspeeds of 50, 100 and 128 knots at approximately 9300 pounds gross weight and an approximately mid C.G. Lateral control response was characterized by high roll rate damping. In most cases the roll rate was over-damped. At maximum airspeeds roll rate response was approximately 10 degrees/second/inch or 5 degrees/second/pound of force, which was less than optimum. Responses after 1 second for 1-inch and 2-inch inputs were approximately 8 degrees and 15 degrees respectively. For the armed mission, roll response of 15 to 20 degrees/second/inch with maximum roll rates of approximately 50 degrees to 70 degrees/second is desirable.

4.13.3.2 Qualitatively, the longitudinal control response was satisfactory. The response was similar in sensitivity, damping and rate to that of most helicopters of this class. During maneuvering flight the effect of the "bob weight" was very noticeable in the longitudinal axis, where it caused a stick force proportional to g. This force, although unusual when first experienced, improved maneuvering stability.

4.13.3.3 Qualitatively, the directional control response was heavily damped and pedal forces were high. Due to the longitudinal trim change associated with sideslip, directional control step inputs caused a nose-down pitch with right pedal and a small nose-up pitch with left pedal. This characteristic is undesirable for weapons firing.

4.13.4 MANEUVERING STABILITY

4.13.4.1 Maneuvering stability characteristics were investigated in terms of stick position and stick force per g. Standard flight test techniques were used. Plots of stick position (stick-fixed) and stick force (stick-free) per g are presented in Figures 41 and 42. The aircraft was evaluated with the ASE OFF at average gross weights of 7900 pounds and 9130 pounds at density altitudes of 3000 feet and 4000 feet respectively. The primary technique used was the symmetrical pull-up since this was the most critical case. Wind-up turns and spiral dives were qualitatively checked and in both cases larger maneuver margins were apparent. The ASE was also qualitatively checked and increased maneuver margins were apparent with the ASE ON.

4.13.4.2 The maneuvering stability test results at 7900 pounds gross weight, in terms of stick force versus g and stick displacement from trim versus g are presented in Figure 41. The results in both cases show a decreasing maneuver margin with increasing airspeed. Positive stick-fixed maneuver margins are shown at 80 KCAS and 100 KCAS, but at 120 KCAS and 140 KCAS neutral and negative stick-fixed margins respectively are shown. This indicates that as g was applied the rotor disc was flapping back, and that, after initiating the pull-up with aft stick, forward stick had to be applied to prevent g from increasing above the desired value. Thus the "bob weight" effectiveness was reduced and the resulting stick force per g was reduced. Results of the stick-free maneuver margin tests are similar to the stick-fixed results in that at 80 and 100 KCAS a positive stick force per g exists which then becomes neutral at 120 KCAS and negative at 140 KCAS.

4.13.4.3 The effect of increased weight on maneuvering stability was determined by repeating the tests at 9130 pounds. These test results are shown in Figure 42. The same trend as in the lightweight tests is apparent, but the speeds at which significant reductions in maneuvering stability occur are lower. Stick force per g as a function of g also decreases at a greater rate and at lower g values. This would be explained by the earlier onset of blade stall at the heavier weights. At 120 KCAS and 9130 pounds (See Figure 42), negative stick-fixed stability exists at all values of g. Thus, if the stick is held in the aft displaced position, a divergent pitch-up results (See Figure 43, time history of an aft longitudinal step). This continues until severe blade stall is reached or recovery action is initiated. As shown in Figure 43, the divergence continues in spite of slow forward stick motion. Note that aft stick force increases slightly under the influence of the "bob weight" and that, when the stick is released, corrective forward stick is applied. Collective pitch reduction is necessary, however, due to the severity of the blade stall. This characteristic is prohibited by Paragraph 3.2.8, MIL-H-8501A (Reference e). Inadequate warning of the pitch-up exists. This indicates that a limited dive recovery envelope should be imposed.

4.13.4.4 Qualitatively, under conditions where speeds below 115 KCAS and weights below 8500 pounds were used, the maneuvering stability of the UH-2B was good up to 2.5 g. The "bob weight" provided excellent stick-force-per-g characteristics and high load factors could be used with confidence and precision. The trend of stick-free maneuvering stability with increased g, weight, and airspeed was one of reduced maneuvering stability. The problem appeared to be that of increasing unstable rotor flap-back as blade stall was approached, causing negative stick position per g. The "bob weight" force was, therefore, canceled out by the pilot's having to allow the stick to move forward. This effect became very pronounced during symmetrical diving pull-outs at heavy gross weights and high speeds that resulted in a divergent longitudinal pitch-up in which load factor rapidly built up until heavy blade stall was encountered and immediate recovery was essential. In turning flight the effect was less pronounced.

4.13.5 DYNAMIC LATERAL DIRECTIONAL STABILITY

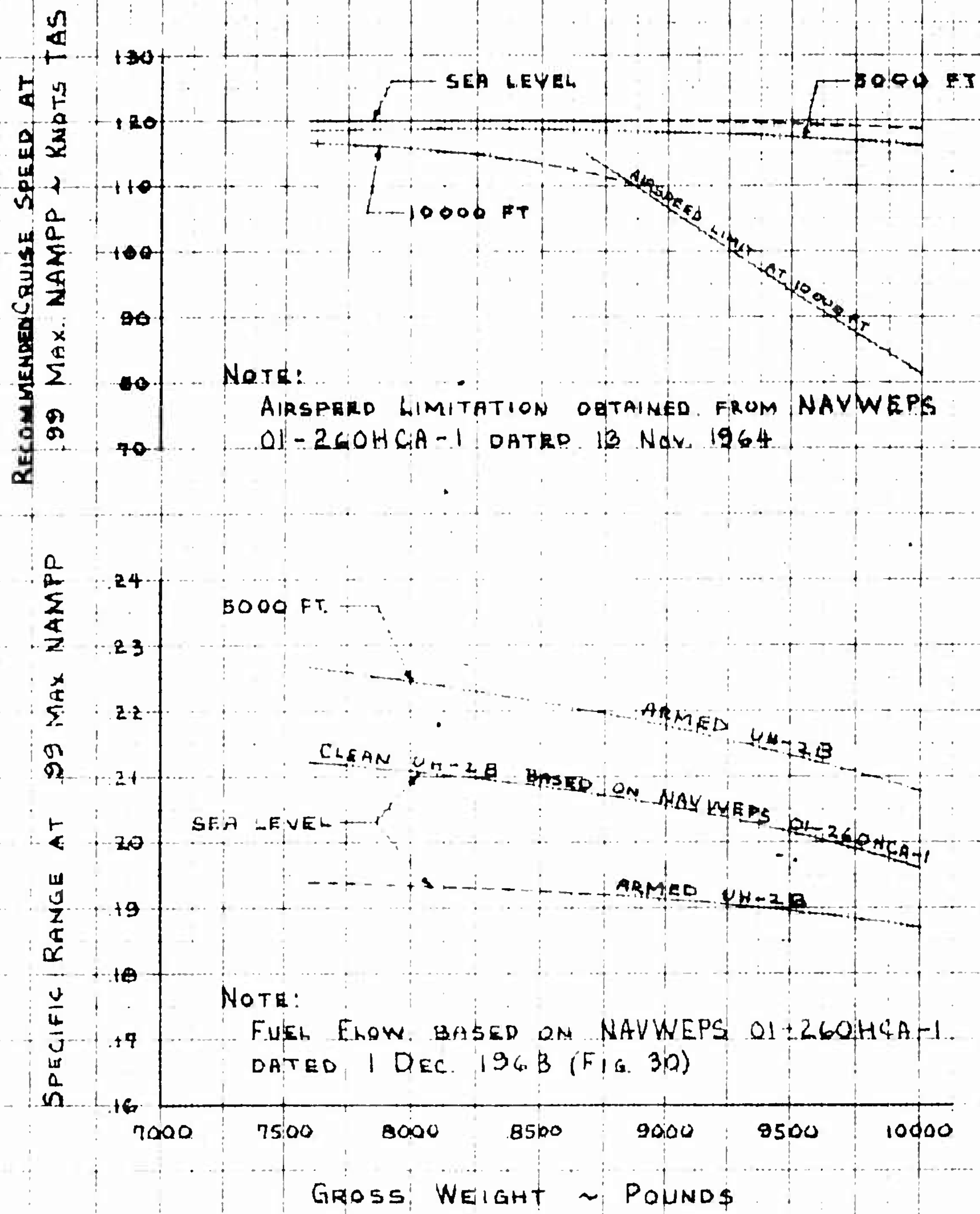
Limited dynamic lateral directional stability tests were conducted at 120 KCAS, 9280 pounds and 2900 feet density altitude. Pedal releases were made from a 10-degree sideslip and time histories are presented in Figures 44 and 45. As can be seen in Figure 44, aircraft response with the yaw damper ON from a 10-degree release is "dead beat." Figure 45 shows that with a yaw damper OFF, approximately 1.7 seconds and 1.5 cycles are required for the aircraft to damp to half amplitude. The use of the yaw damper increases the effectiveness of the aircraft as a weapons platform.

SECTION 2. APPENDICES

APPENDIX I

TEST DATA

Figure No. 1
Level Flight Range Summary
UH-2B USN S/N 15-2202
Rotor Speed = 277 RPM
Avg. C.G. Station = 166.1 in. (mid)
Gear Up
Simulated T.A.T. 141
Two LAU 3A/A 19 round
pods without nose cones



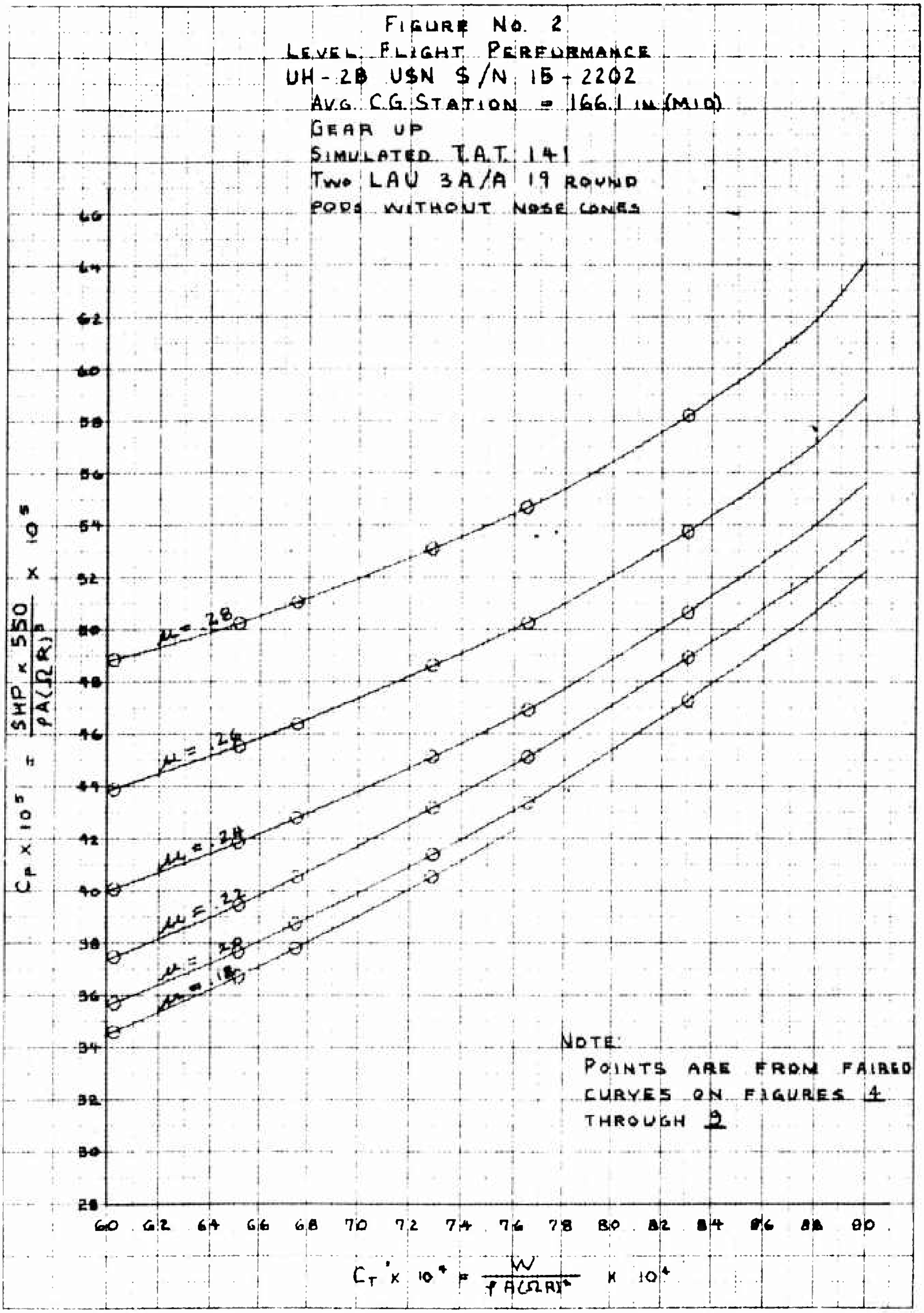


FIGURE NO. 2
LEVEL FLIGHT PERFORMANCE
UH-2B USN S/N 15-2202
AVG. C.G. STATION = 166.1 IN. (MID)
GEAR UP
SIMULATED T.A.T. 141
TWO LAU 3A/A 19 ROUND
PODS WITHOUT NOSE CONES
$\mu = .28$
$\mu = .26$
$\mu = .24$
$\mu = .22$
$\mu = .20$
$\mu = .18$
NOTE:
POINTS ARE FROM FAIRED CURVES ON FIGURES 4 THROUGH 9
$C_P \times 10^5 = \frac{SHP \times 550}{\rho A (\Omega R)^3} \times 10^5$
$C_T' \times 10^4 = \frac{W}{\rho A (\Omega R)^2} \times 10^4$
28
30
32
34
36
38
40
42
44
46
48
50
52
54
56
58
60
62
64
66
60
62
64
66
68
70
72
74
76
78
80
82
84
86
88
90

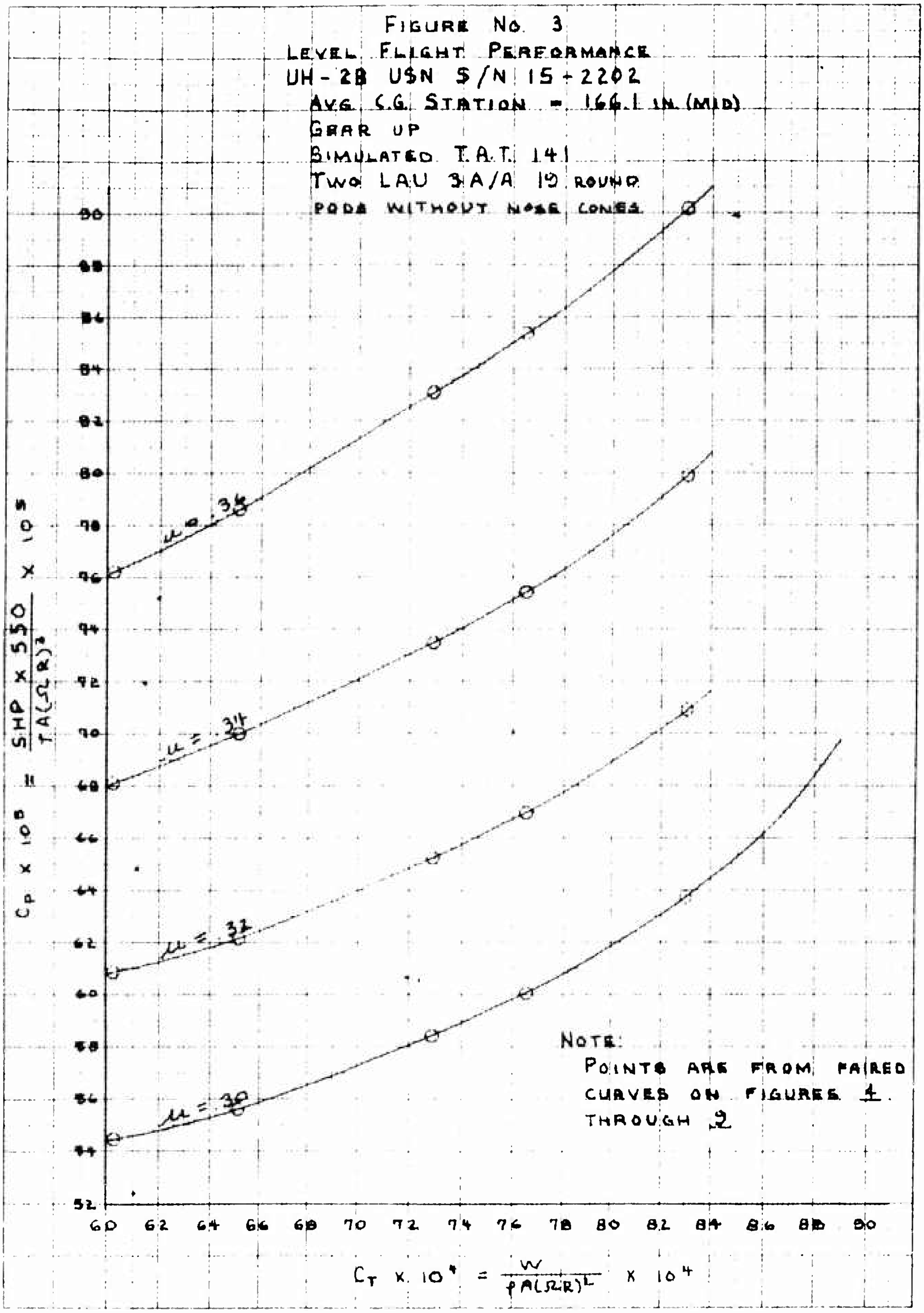


FIGURE NO. 3
LEVEL FLIGHT PERFORMANCE
UH-2B USN S/N 15-2202
AVG. C.G. STATION = 166.1 IN. (MID)
GEAR UP
SIMULATED T.A.T. 141
TWO LAU 3A/A 19 ROUND
PODS WITHOUT NOSE CONES
$\mu = .36$
$\mu = .34$
$\mu = .32$
$\mu = .30$
NOTE:
POINTS ARE FROM FAIRED
CURVES ON FIGURES 4
THROUGH 9
$C_P \times 10^5 = \frac{SHP \times 550}{\rho A(\Omega R)^3} \times 10^5$
90
88
86
84
82
80
78
76
74
72
70
68
66
64
62
60
58
56
54
52
60
62
64
66
68
70
72
74
76
78
80
82
84
86
88
90
$C_T \times 10^4 = \frac{W}{\rho A(\Omega R)^2} \times 10^4$

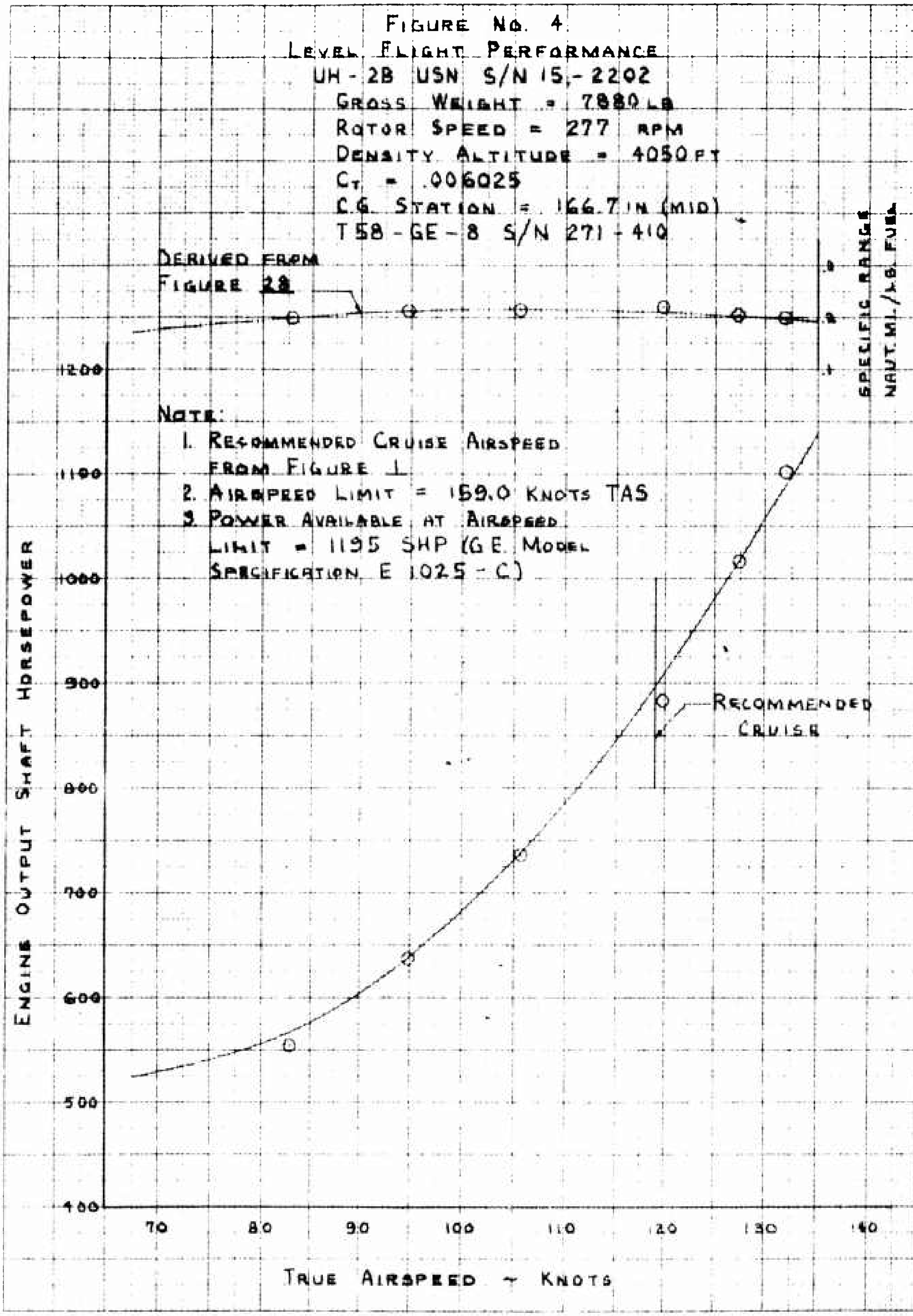


FIGURE NO. 4
LEVEL FLIGHT PERFORMANCE
UH-2B USN S/N 15-2202
GROSS WEIGHT = 7880 LB
ROTOR SPEED = 277 RPM
DENSITY ALTITUDE = 4050 FT
CT = .006025
C.G. STATION = 166.7 IN (MID)
T58-GE-8 S/N 271-410
DERIVED FROM FIGURE 28
SPECIFIC RANGE NAUT. MI./LB. FUEL
NOTE:
1. RECOMMENDED CRUISE AIRSPEED FROM FIGURE 1
2. AIRSPEED LIMIT = 159.0 KNOTS TAS
3. POWER AVAILABLE AT AIRSPEED LIMIT = 1195 SHP (G.E. MODEL SPECIFICATION E 1025-C)
RECOMMENDED CRUISE
ENGINE OUTPUT SHAFT HORSEPOWER
TRUE AIRSPEED ~ KNOTS

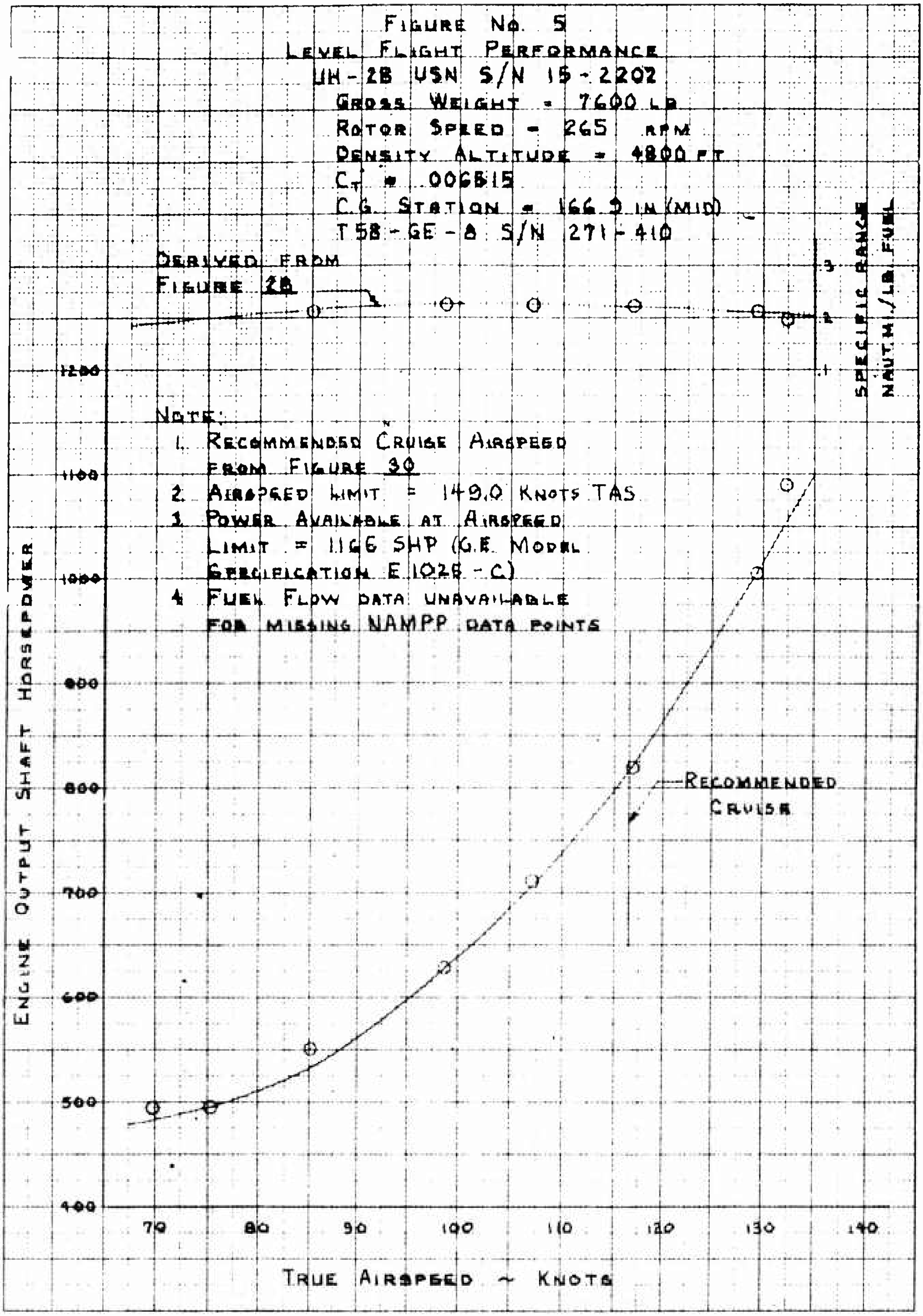


FIGURE NO. 5
LEVEL FLIGHT PERFORMANCE
UH-2B USN S/N 15-2202
GROSS WEIGHT = 7600 LB
ROTOR SPEED = 265 RPM
DENSITY ALTITUDE = 4800 FT
C_T = .006515
C.G. STATION = 166.9 IN (MID)
T58-GE-8 S/N 271-410
DERIVED FROM FIGURE 28
SPECIFIC RANGE NAUT.MI./LB. FUEL
NOTE:
1. RECOMMENDED CRUISE AIRSPEED FROM FIGURE 30
2. AIRSPEED LIMIT = 149.0 KNOTS TAS
3. POWER AVAILABLE AT AIRSPEED LIMIT = 1166 SHP (G.E. MODEL SPECIFICATION E 1026-C)
4. FUEL FLOW DATA UNAVAILABLE FOR MISSING NAMPP DATA POINTS
RECOMMENDED CRUISE
ENGINE OUTPUT SHAFT HORSEPOWER
TRUE AIRSPEED ~ KNOTS

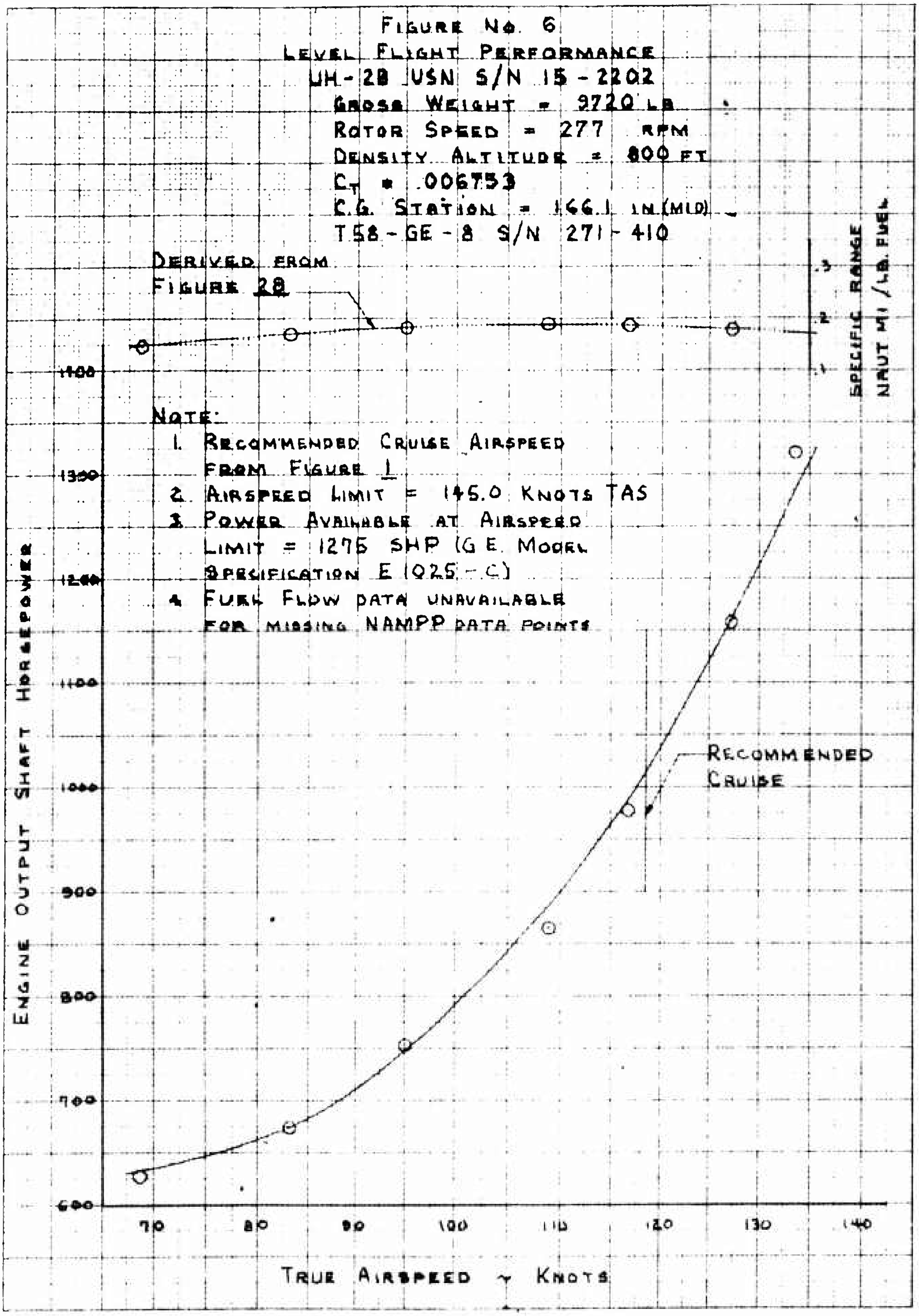


Figure No. 6
Level Flight Performance
UH-2B USN S/N 15-2202
Gross Weight = 9720 LB
Rotor Speed = 277 RPM
Density Altitude = 800 FT
CT = .006753
C.G. Station = 166.1 IN (MID)
T58-GE-8 S/N 271-410
Derived from Figure 28
Specific Range
Naut Mi / LB. Fuel
.3
.2
.1
Note:
1. Recommended Cruise Airspeed from Figure 1
2. Airspeed Limit = 145.0 Knots TAS
3. Power Available at Airspeed Limit = 1275 SHP (G.E. Model Specification E 1025-C)
4. Fuel Flow data unavailable for missing NAMPP data points
Recommended Cruise
Engine Output Shaft Horsepower
1400
1300
1200
1100
1000
900
800
700
600
70
80
90
100
110
120
130
140
True Airspeed ~ Knots

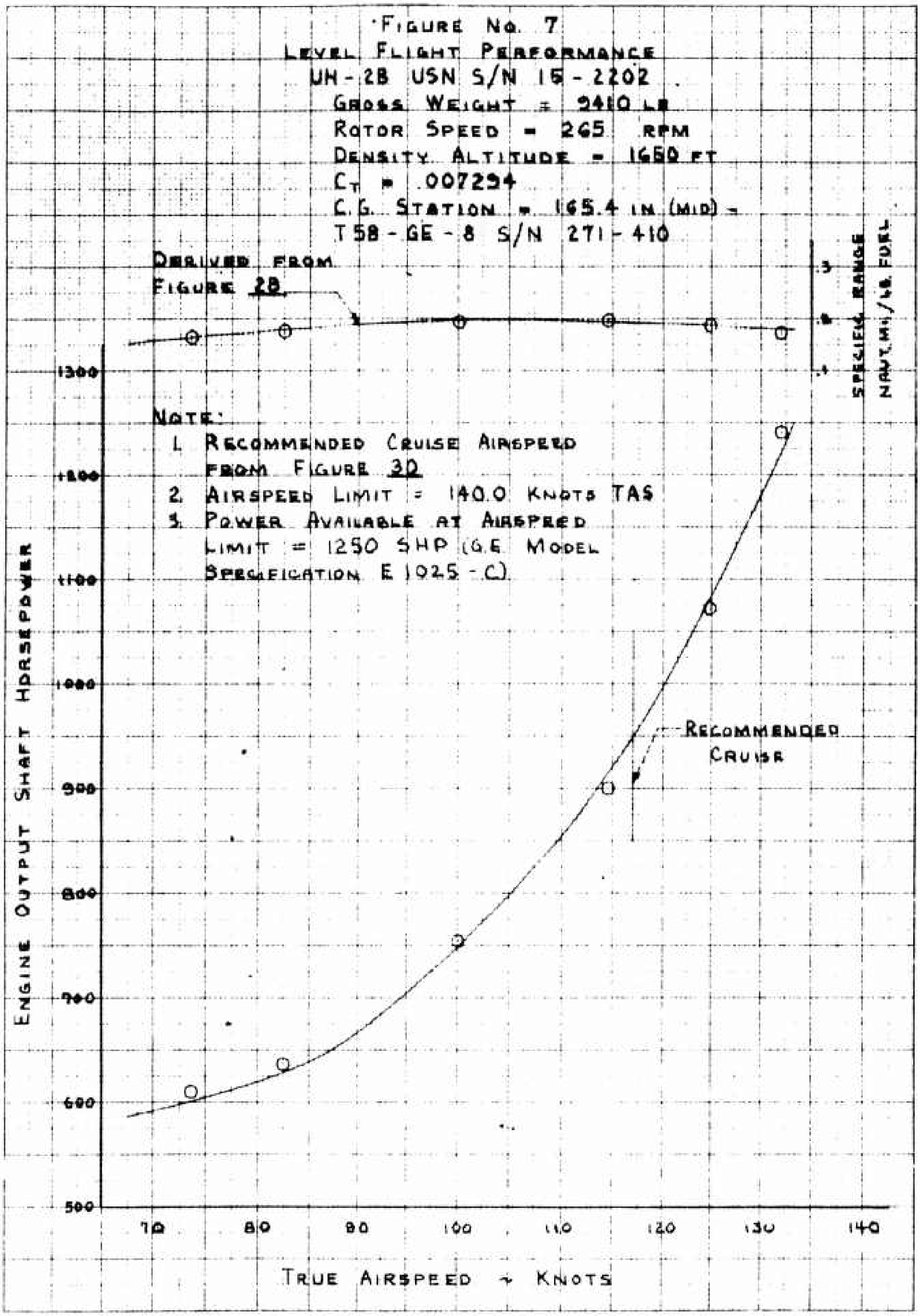


Figure No. 7
Level Flight Performance
UH-2B USN S/N 15-2202
Gross Weight = 9410 lb
Rotor Speed = 265 RPM
Density Altitude = 1650 ft
C_T = .007294
C.G. Station = 165.4 in (mid)
T58-GE-8 S/N 271-410
Derived from Figure 28
Specific Range Naut. Mi./Lb. Fuel
.3
.2
.1
Note:
1. Recommended Cruise Airspeed from Figure 30
2. Airspeed Limit = 140.0 Knots TAS
3. Power Available at Airspeed Limit = 1250 SHP (G.E. Model Specification E 1025-C)
Recommended Cruise
Engine Output Shaft Horsepower
1300
1200
1100
1000
900
800
700
600
500
70
80
90
100
110
120
130
140
True Airspeed ~ Knots

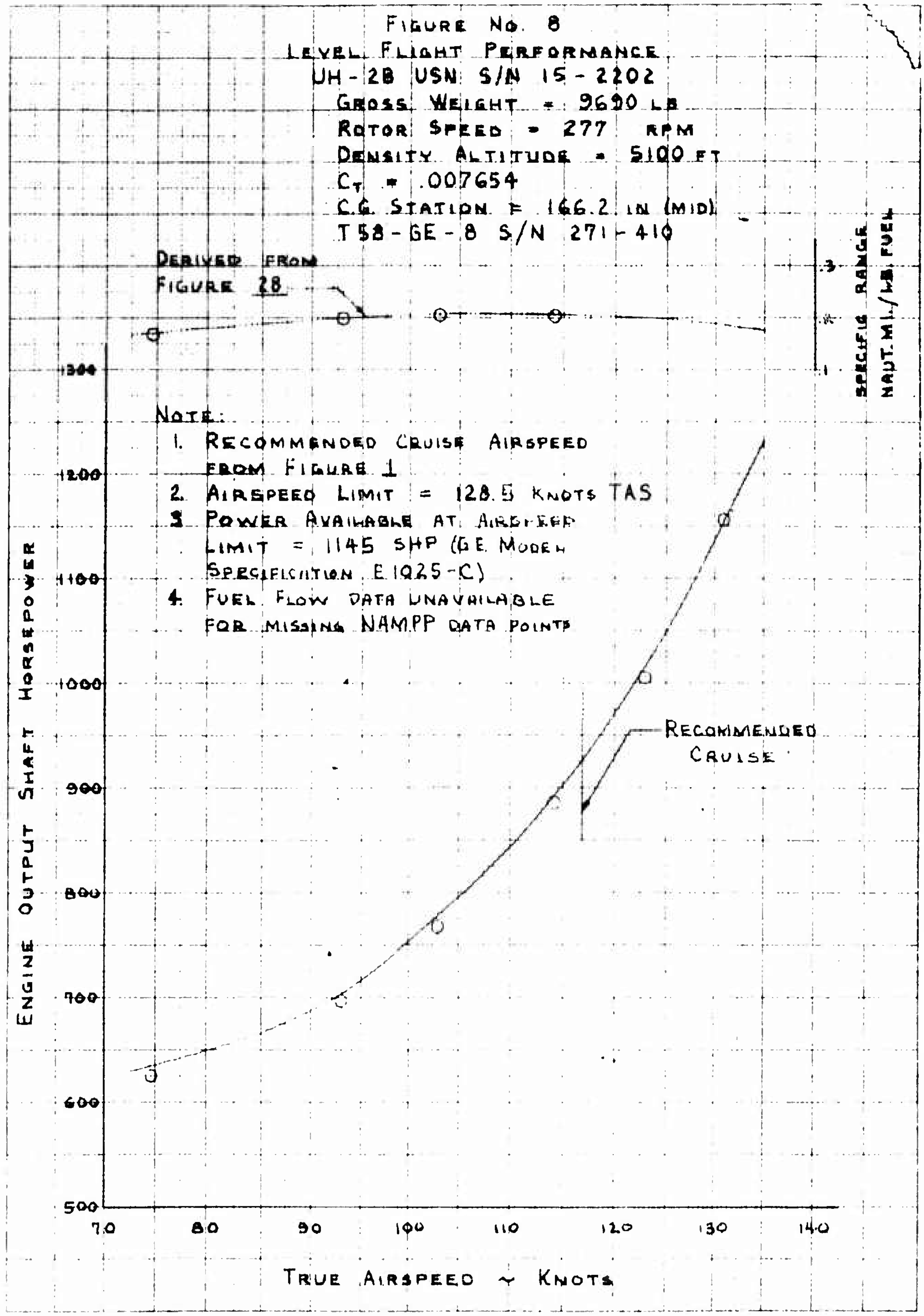


FIGURE NO. 8
LEVEL FLIGHT PERFORMANCE
UH-2B USN S/N 15-2202
GROSS WEIGHT = 9690 LB
ROTOR SPEED = 277 RPM
DENSITY ALTITUDE = 5100 FT
C_T = .007654
C.G. STATION = 166.2 IN (MID)
T58-GE-8 S/N 271-410
DERIVED FROM FIGURE 28
SPECIFIC RANGE NAUT. MI./LB. FUEL
.3
.2
.1
NOTE:
1. RECOMMENDED CRUISE AIRSPEED FROM FIGURE 1
2. AIRSPEED LIMIT = 128.5 KNOTS TAS
3. POWER AVAILABLE AT AIRSPEED LIMIT = 1145 SHP (GE MODEL SPECIFICATION E1025-C)
4. FUEL FLOW DATA UNAVAILABLE FOR MISSING NAMPP DATA POINTS
RECOMMENDED CRUISE
ENGINE OUTPUT SHAFT HORSEPOWER
1300
1200
1100
1000
900
800
700
600
500
70
80
90
100
110
120
130
140
TRUE AIRSPEED ~ KNOTS

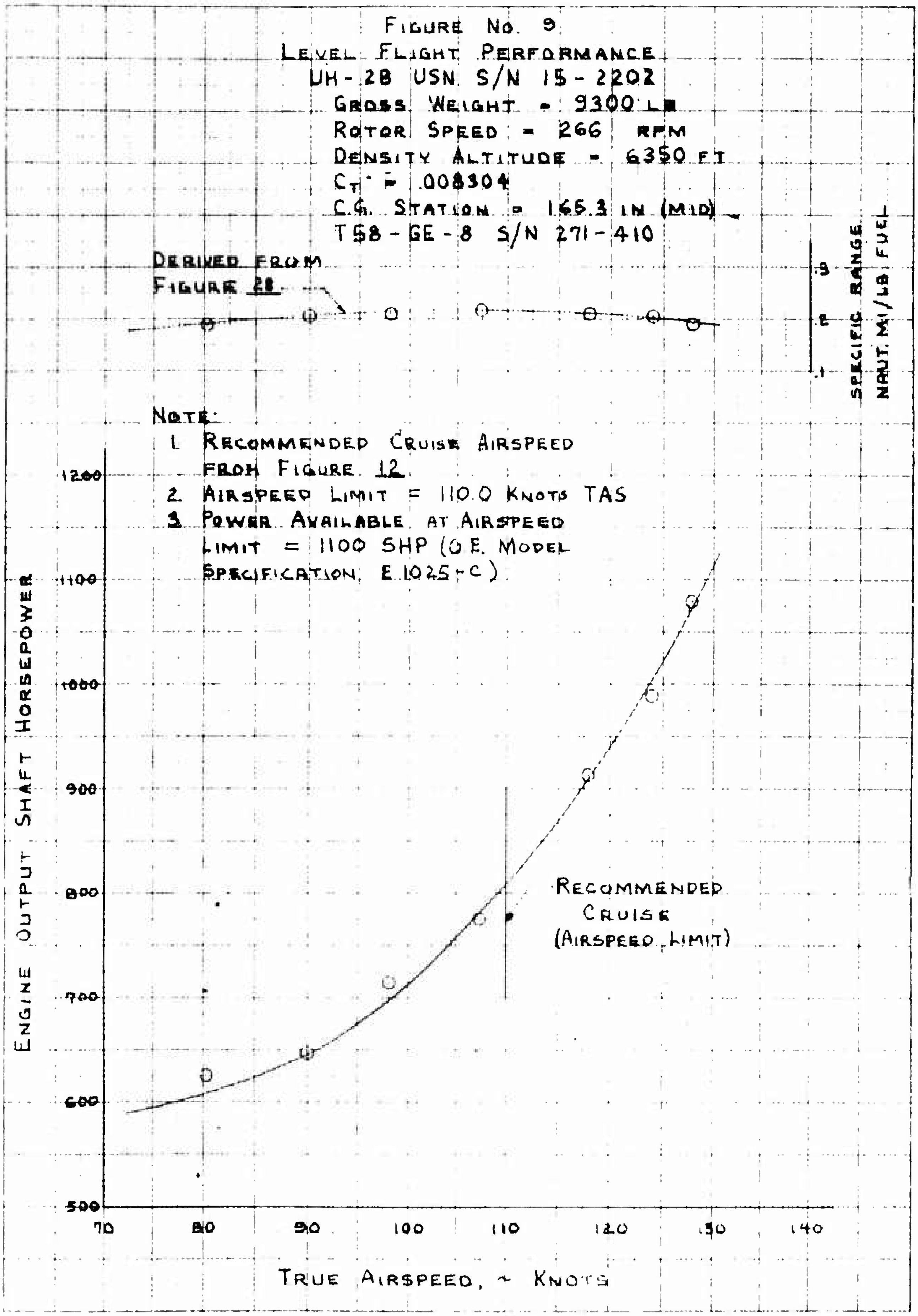


Figure No. 9
Level Flight Performance
UH-2B USN S/N 15-2202
Gross Weight = 9300 LB
Rotor Speed = 266 RPM
Density Altitude = 6350 FT
C_T = .008304
C.G. Station = 165.3 IN (MID)
T58-GE-8 S/N 271-410
Derived from Figure 28
Specific Range Naut. Mi/Lb Fuel
.3
.2
.1
Note:
1. Recommended Cruise Airspeed from Figure 12.
2. Airspeed Limit = 110.0 Knots TAS
3. Power Available at Airspeed Limit = 1100 SHP (G.E. Model Specification E 1025-C)
Engine Output Shaft Horsepower
1200
1100
1000
900
800
700
600
500
Recommended Cruise (Airspeed Limit)
70
80
90
100
110
120
130
140
True Airspeed, ~ Knots

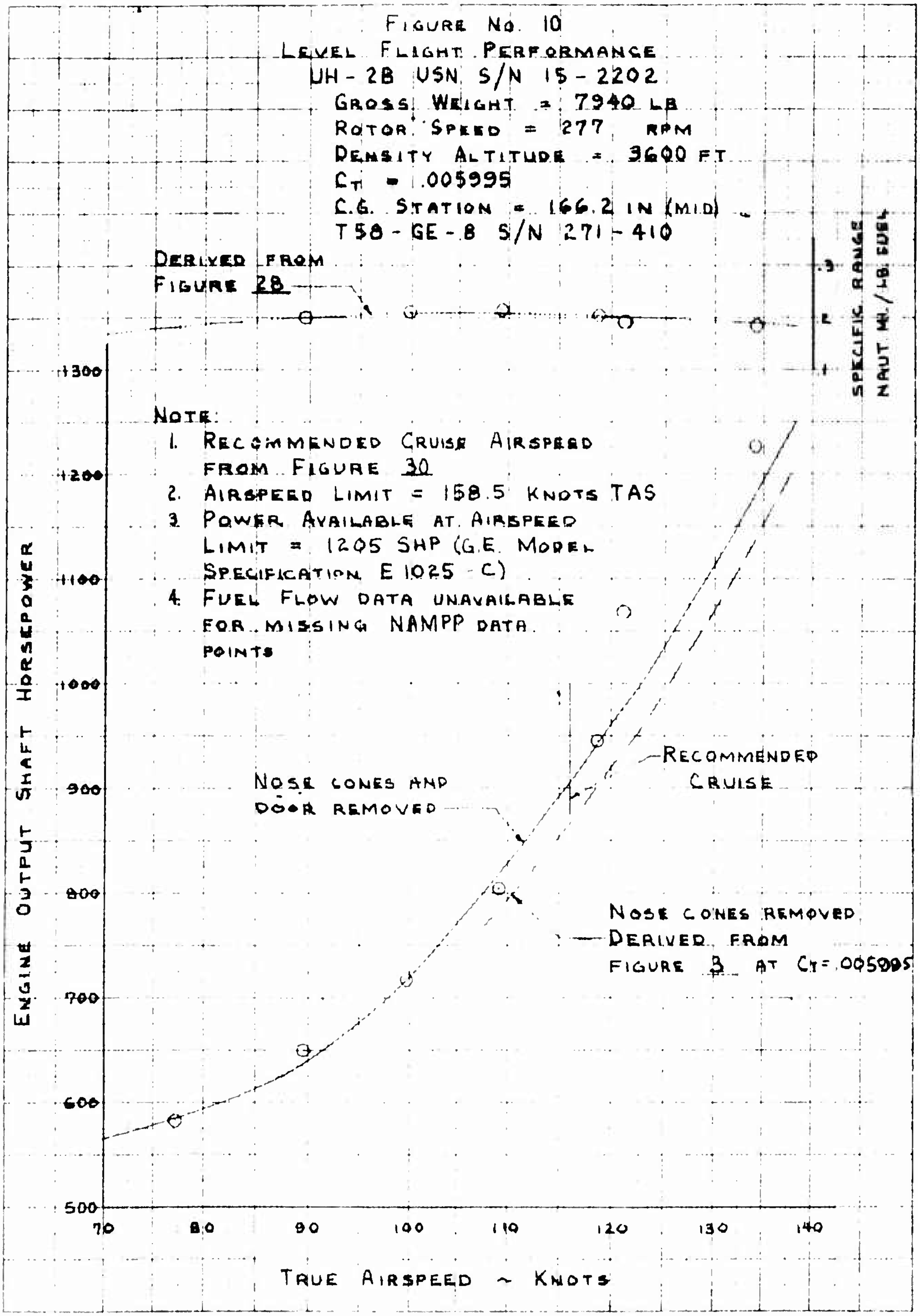


FIGURE NO. 10
LEVEL FLIGHT PERFORMANCE
UH-2B USN S/N 15-2202
GROSS WEIGHT = 7940 LB
ROTOR SPEED = 277 RPM
DENSITY ALTITUDE = 3600 FT
CT = .005995
C.G. STATION = 166.2 IN (MID)
T58-GE-8 S/N 271-410
DERIVED FROM FIGURE 28
SPECIFIC RANGE NAUT MI./LB. FUEL
.3
.2
.1
NOTE:
1. RECOMMENDED CRUISE AIRSPEED FROM FIGURE 30
2. AIRSPEED LIMIT = 158.5 KNOTS TAS
3. POWER AVAILABLE AT AIRSPEED LIMIT = 1205 SHP (G.E. MODEL SPECIFICATION E 1025-C)
4. FUEL FLOW DATA UNAVAILABLE FOR MISSING NAMPP DATA POINTS
RECOMMENDED CRUISE
NOSE CONES AND DOOR REMOVED
NOSE CONES REMOVED
DERIVED FROM FIGURE 3 AT CT = .005995
ENGINE OUTPUT SHAFT HORSEPOWER
1300
1200
1100
1000
900
800
700
600
500
70
80
90
100
110
120
130
140
TRUE AIRSPEED ~ KNOTS

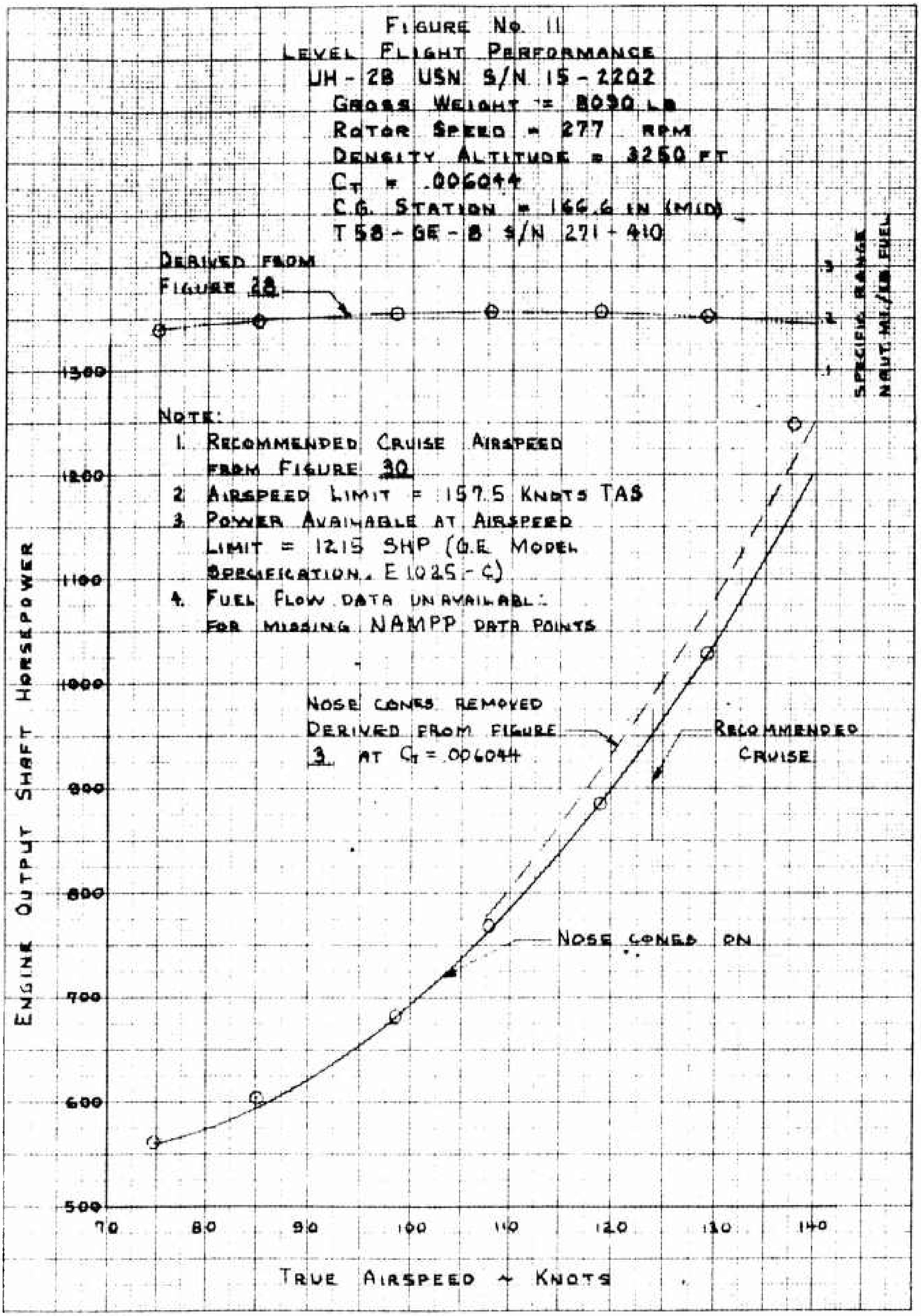


FIGURE No. 11
LEVEL FLIGHT PERFORMANCE
UH-2B USN S/N 15-2202
GROSS WEIGHT = 8030 LB
ROTOR SPEED = 277 RPM
DENSITY ALTITUDE = 3250 FT
CT = .006044
C.G. STATION = 166.6 IN (MID)
T58-GE-8 S/N 271-410
DERIVED FROM FIGURE 28
SPECIFIC RANGE NAUT. MI./LB FUEL
NOTE:
1. RECOMMENDED CRUISE AIRSPEED FROM FIGURE 30
2. AIRSPEED LIMIT = 157.5 KNOTS TAS
3. POWER AVAILABLE AT AIRSPEED LIMIT = 1215 SHP (G.E. MODEL SPECIFICATION, E1025-C)
4. FUEL FLOW DATA UNAVAILABLE FOR MISSING NAMPP DATA POINTS
NOSE CONES REMOVED DERIVED FROM FIGURE 3 AT CT = .006044
RECOMMENDED CRUISE
NOSE CONES ON
ENGINE OUTPUT SHAFT HORSEPOWER
TRUE AIRSPEED ~ KNOTS

FIGURE NO. 12
AIRSPEED LIMITATION
UH-2B
ROTOR SPEED 266 RPM

BASED ON
NAVWEPS 01-260HCA-1
DATED 13 NOV. 1964

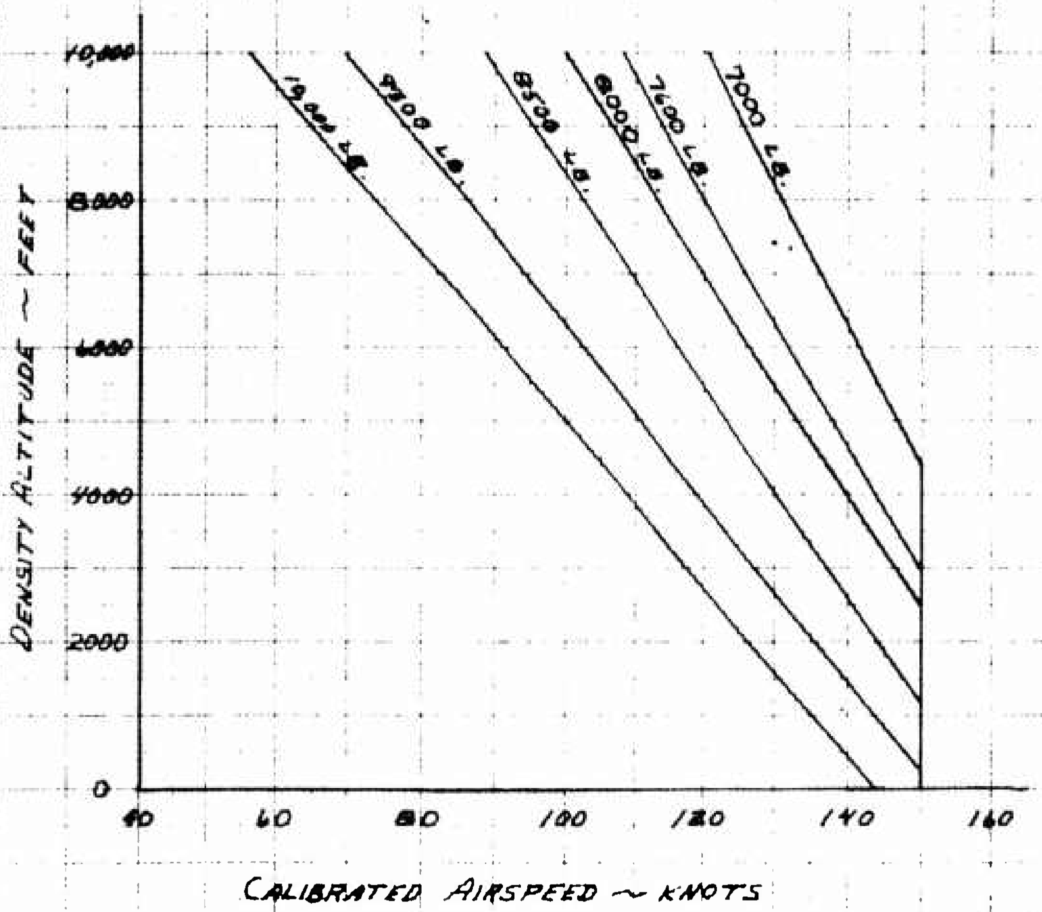


Figure No. 13
Airspeed Limitation
UH-2B USN S/N 15-2202
Rotor Speed = 277 RPM

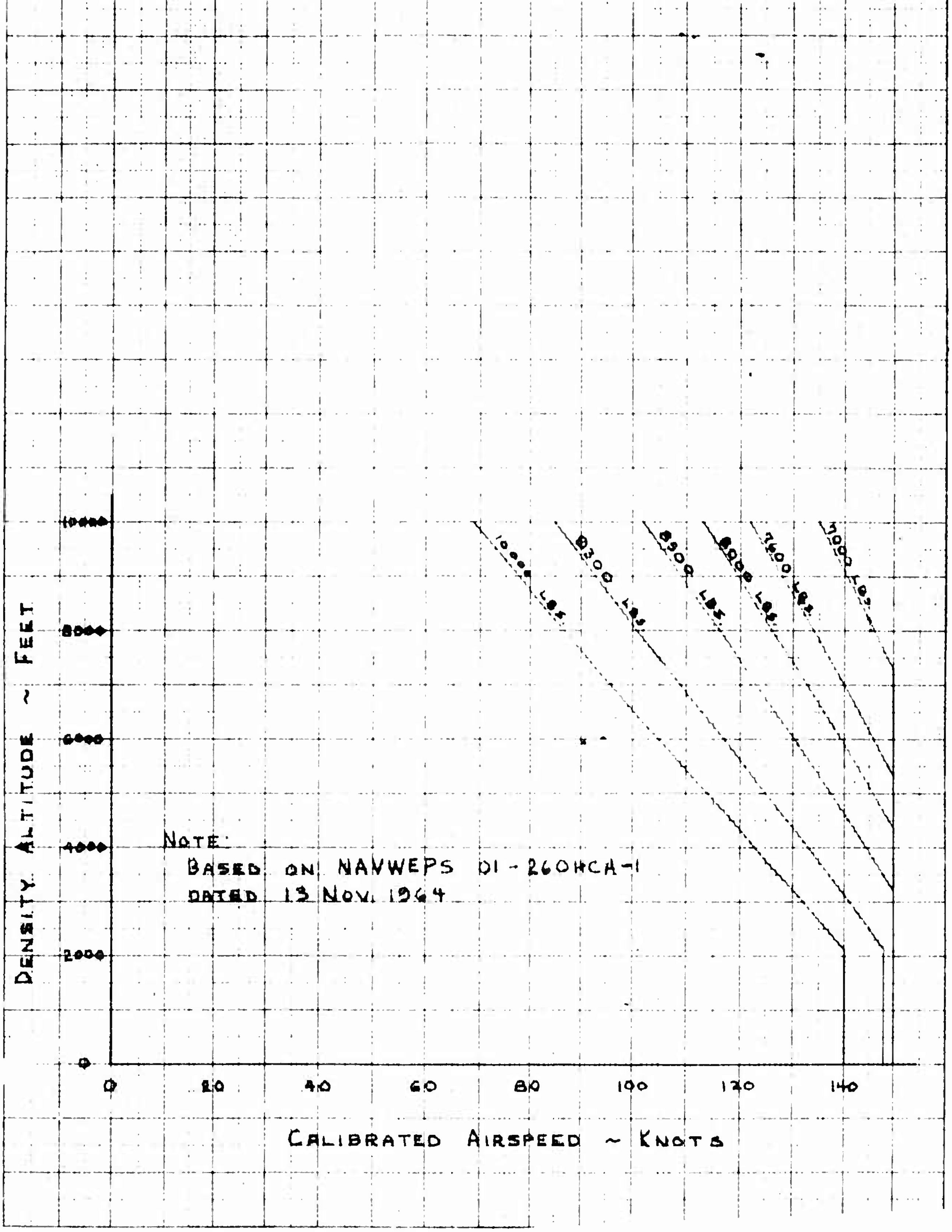


Figure No. 14
Vibration Characteristics
UH-2B USN S/N 15-2202

SYM	GW~LB.	Hp~FT.	RPM	FREQ~CYC/SEC	CG~IN(MID)	CONES	DOOR
○	9670	5100	2766	4.62	164.2	OFF	ON
□	9300	6550	2657	4.44	165.3	OFF	ON
△	~~8090~~	~~5250~~	276.8	4.62	~~166.6~~	~~ON~~	~~ON~~
◇	9360	9700	276.8	4.62	166.6	OFF	ON
D	7940	3600	276.8	4.62	166.2	OFF	OFF
▽	9410	1650	265.7	4.44	165.4	OFF	ON
▷	9720	800	276.8	4.62	166.1	OFF	ON

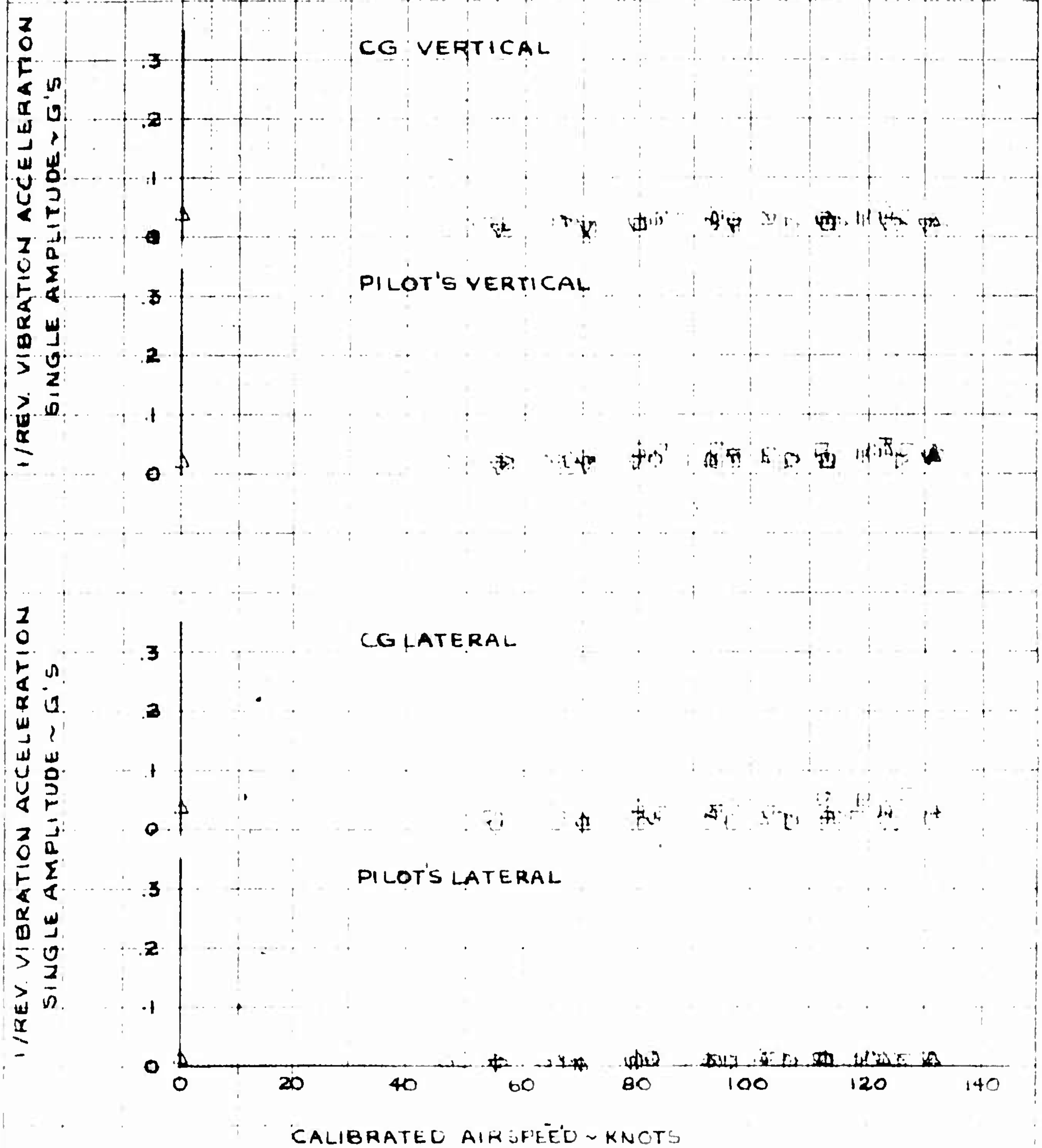


FIGURE NO. 15
VIBRATION CHARACTERISTICS
UH-2B USN S/N 15-2202

SYM	GW~LB	H_p~FT	RPM	FREQ~CYC/SEC	CG~IN (MID)	CANES	DOOR
○	9670	6100	276.8	9.24	166.2	OFF	ON
□	9300	6350	265.7	8.88	165.3	OFF	ON
△	8090	3250	276.8	9.24	166.6	ON	ON
◇	9760	9700	276.8	9.24	166.6	OFF	ON
▱	7940	3600	276.8	9.24	166.2	OFF	OFF
▽	9410	1650	265.7	8.88	165.4	OFF	ON
▷	9720	800	276.8	9.24	166.1	OFF	ON

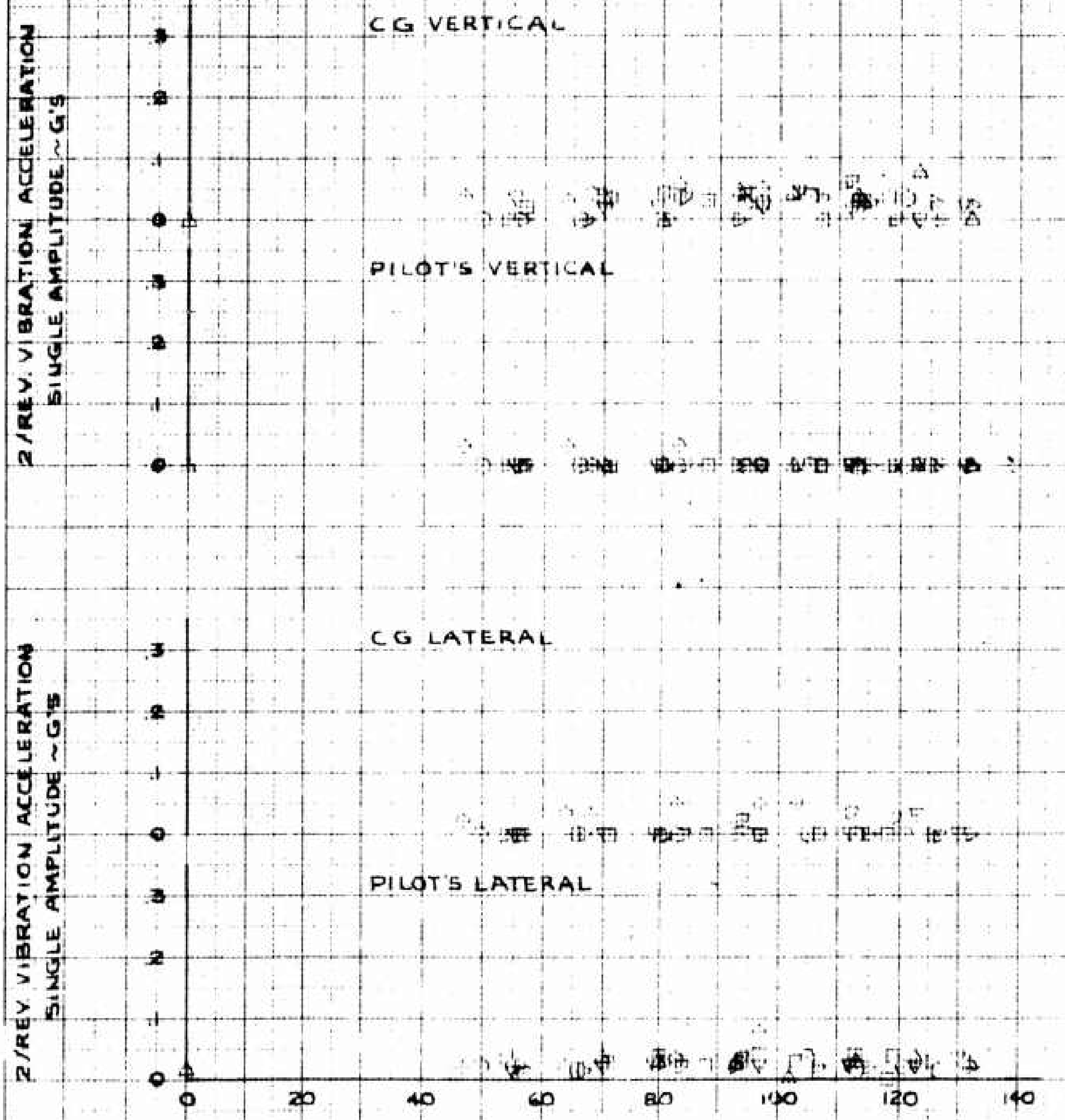


FIGURE NO. 16

VIBRATION CHARACTERISTICS

UH-2B USN S/N 15-2202

SYM	GW ~ LB	H_D ~ FT.	RPM	FREQ ~ CYC/SEC	C.G. ~ IN (MID)	CONES	DOOR
○	9670	5100	276.8	18.48	166.2	OFF	ON
□	9800	6350	265.7	17.76	165.3	OFF	ON
△	8090	5250	276.8	18.48	166.6	ON	ON
◇	9760	9700	276.8	18.48	166.6	OFF	ON
◸	7940	5600	276.8	18.48	166.2	OFF	OFF
▽	9410	1650	265.7	17.76	165.4	OFF	ON
▷	9720	800	276.8	18.48	166.1	OFF	ON

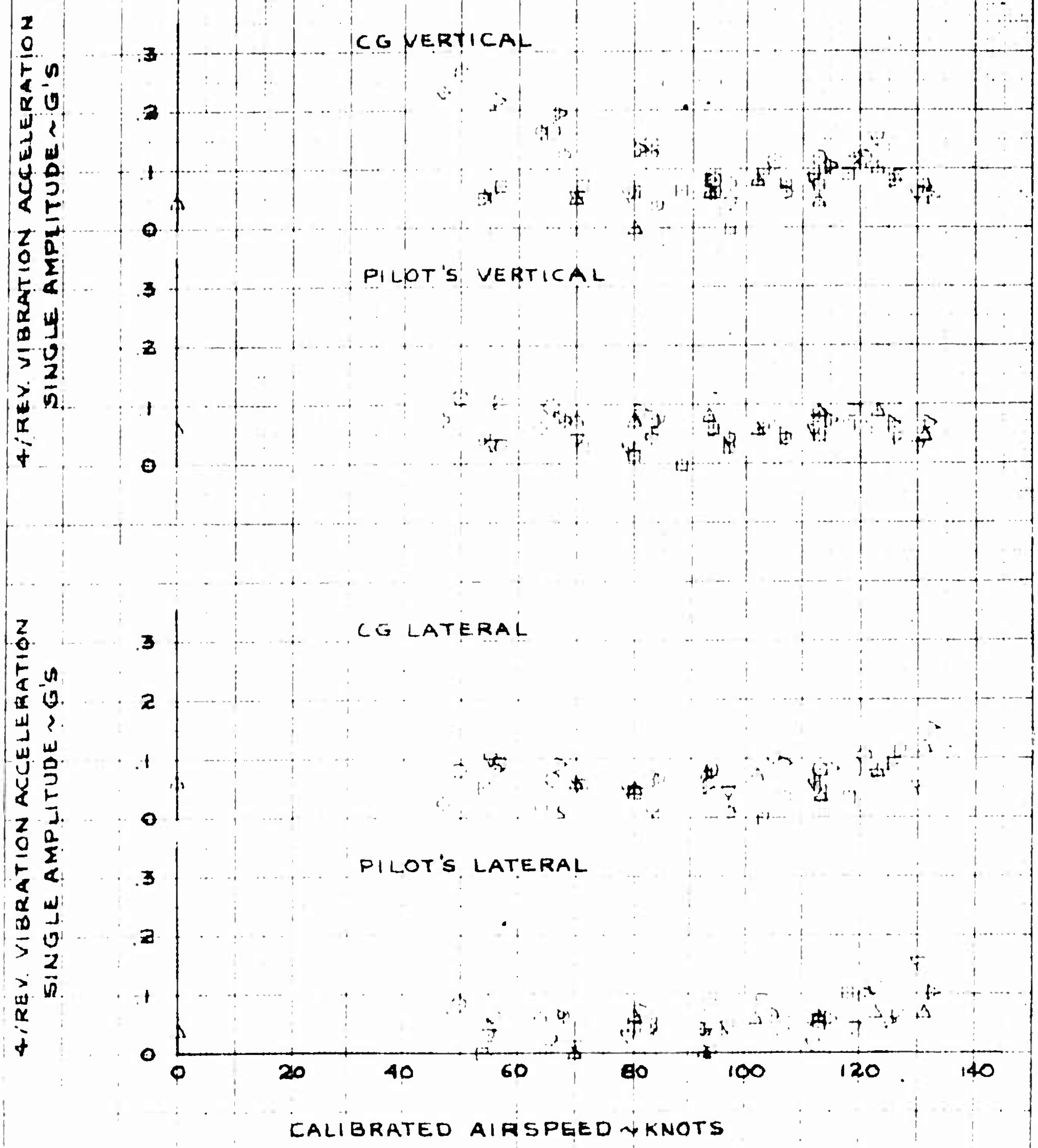
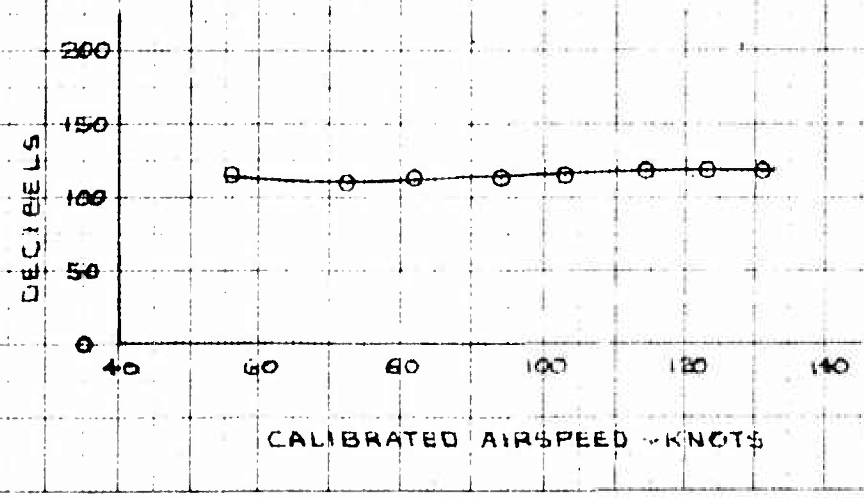


FIGURE No. 17
LEVEL FLIGHT NOISE
LEVEL CHARACTERISTICS
UH-2B USN S/N 15-2201

C.G. STATION +166.5 IN. (MID)
AVG GROSS WT. = 8130 LB.
AVG DENSITY ALT. = 3200 FT.
ROTOR RPM = 277
SIMULATED T.A.T. = 141
TWO LAU 3A/A19 ROUND PODS
WITH NOSE CONES

NOTE:
RECORDING METER PICKUP
LOCATED AT CO-PILOTS HEAD LEVEL



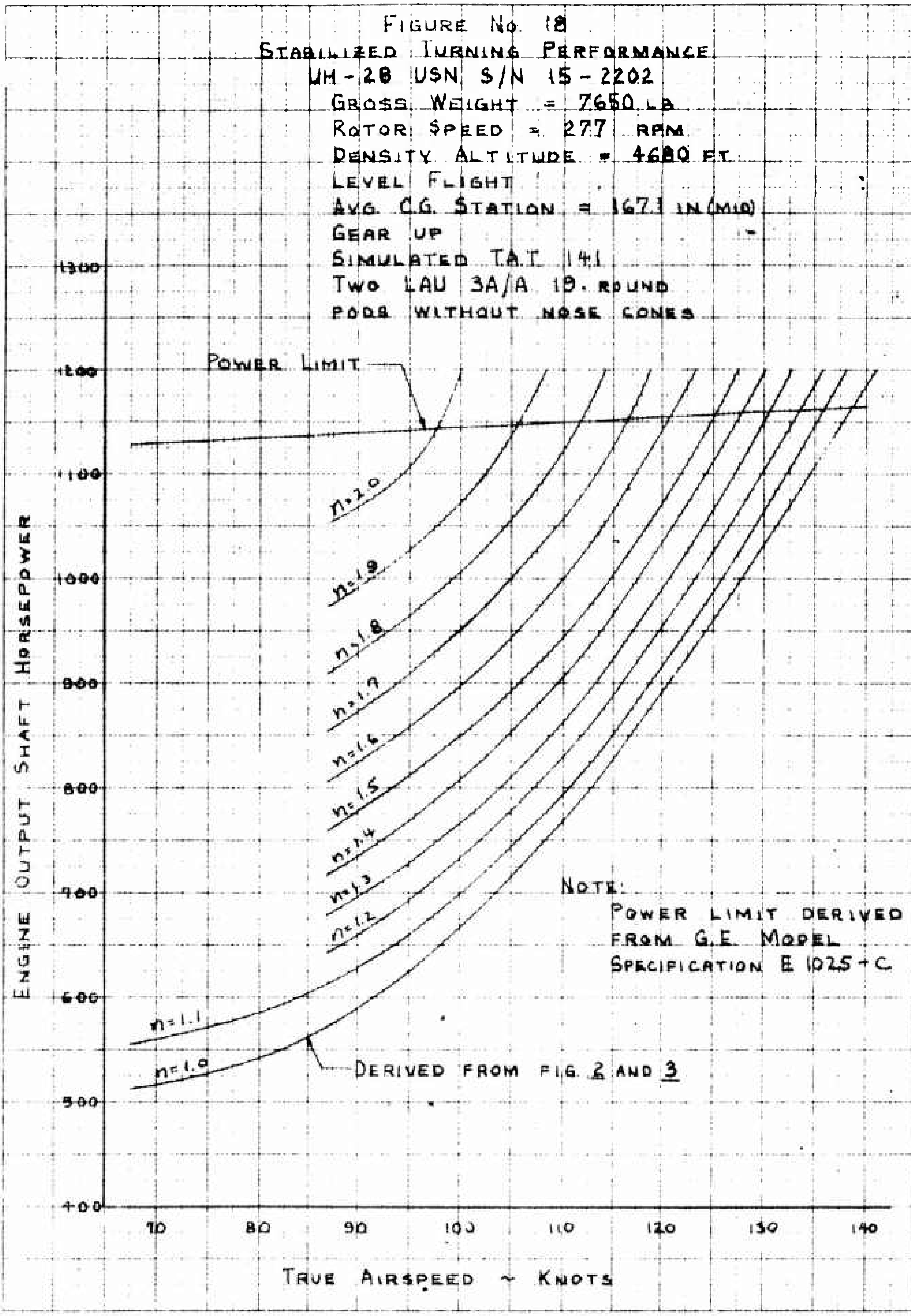
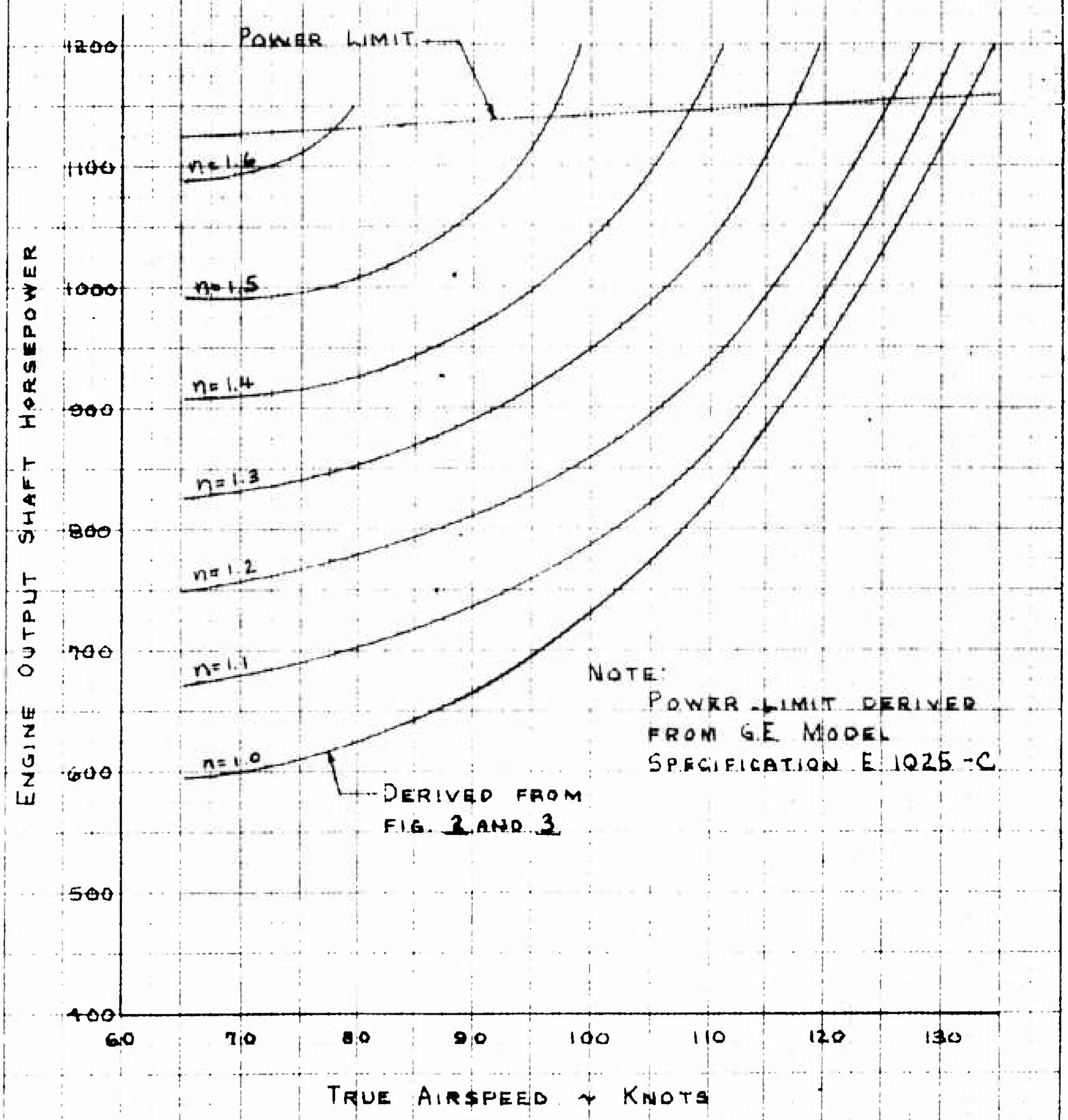


FIGURE NO. 18
STABILIZED TURNING PERFORMANCE
UH-2B USN S/N 15-2202
GROSS WEIGHT = 7650 LB
ROTOR SPEED = 277 RPM
DENSITY ALTITUDE = 4680 FT
LEVEL FLIGHT
AVG. C.G. STATION = 167.1 IN (MID)
GEAR UP
SIMULATED T.A.T. 141
TWO LAU 3A/A 19-ROUND PODS WITHOUT NOSE CONES

FIGURE No. 19
STABILIZED TURNING PERFORMANCE
UH-2B USN S/N 15-2202
GROSS WEIGHT = 9230 LB
ROTOR SPEED = 277 RPM.
DENSITY ALTITUDE = 4750 FT
LEVEL FLIGHT
AVG. C.G. STATION = 166.3 IN (MID)
GEAR UP
SIMULATED T.A.T. 141
TWO LAU 3A/A 19 ROUND
PODS WITHOUT NOSE CONES



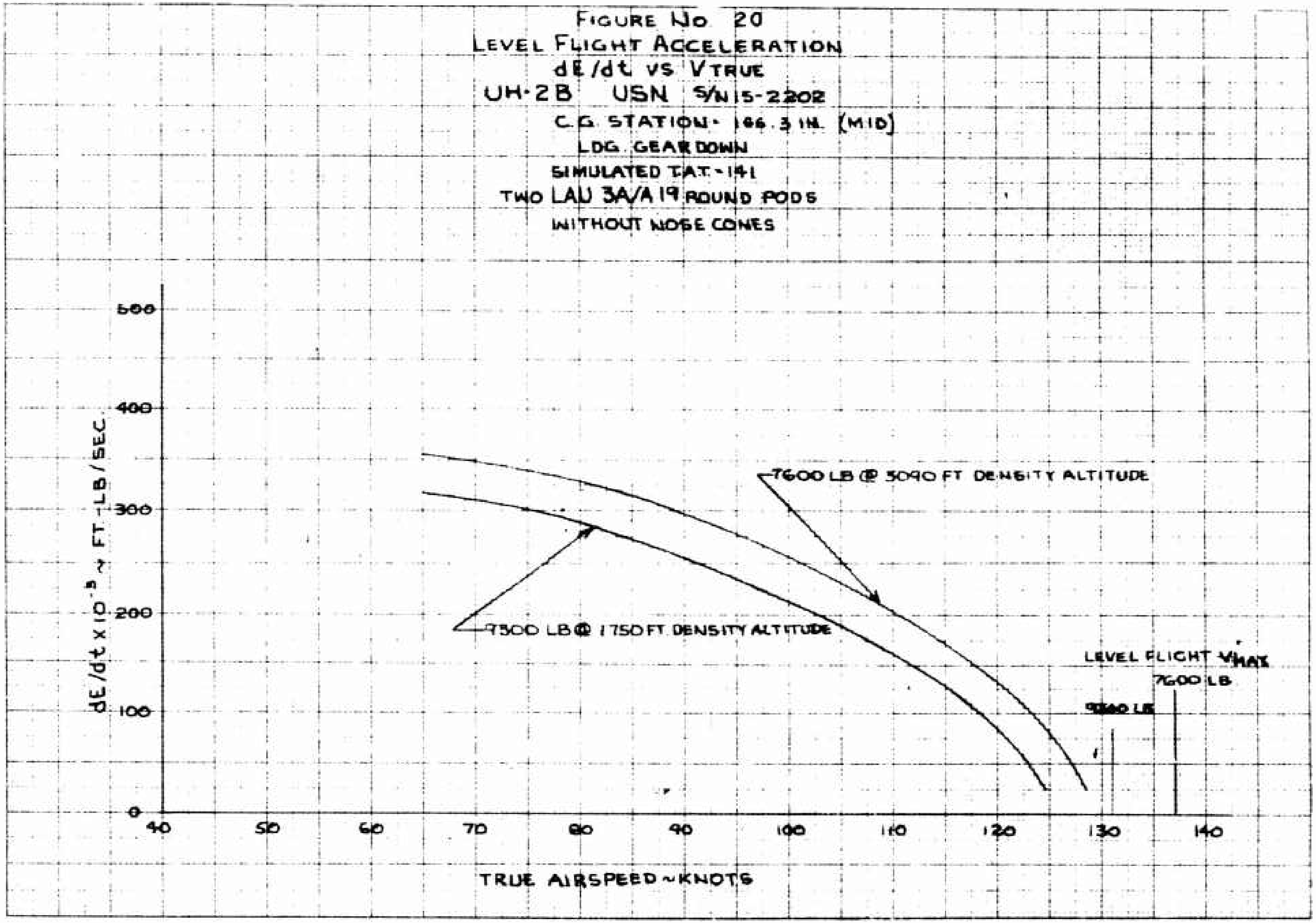
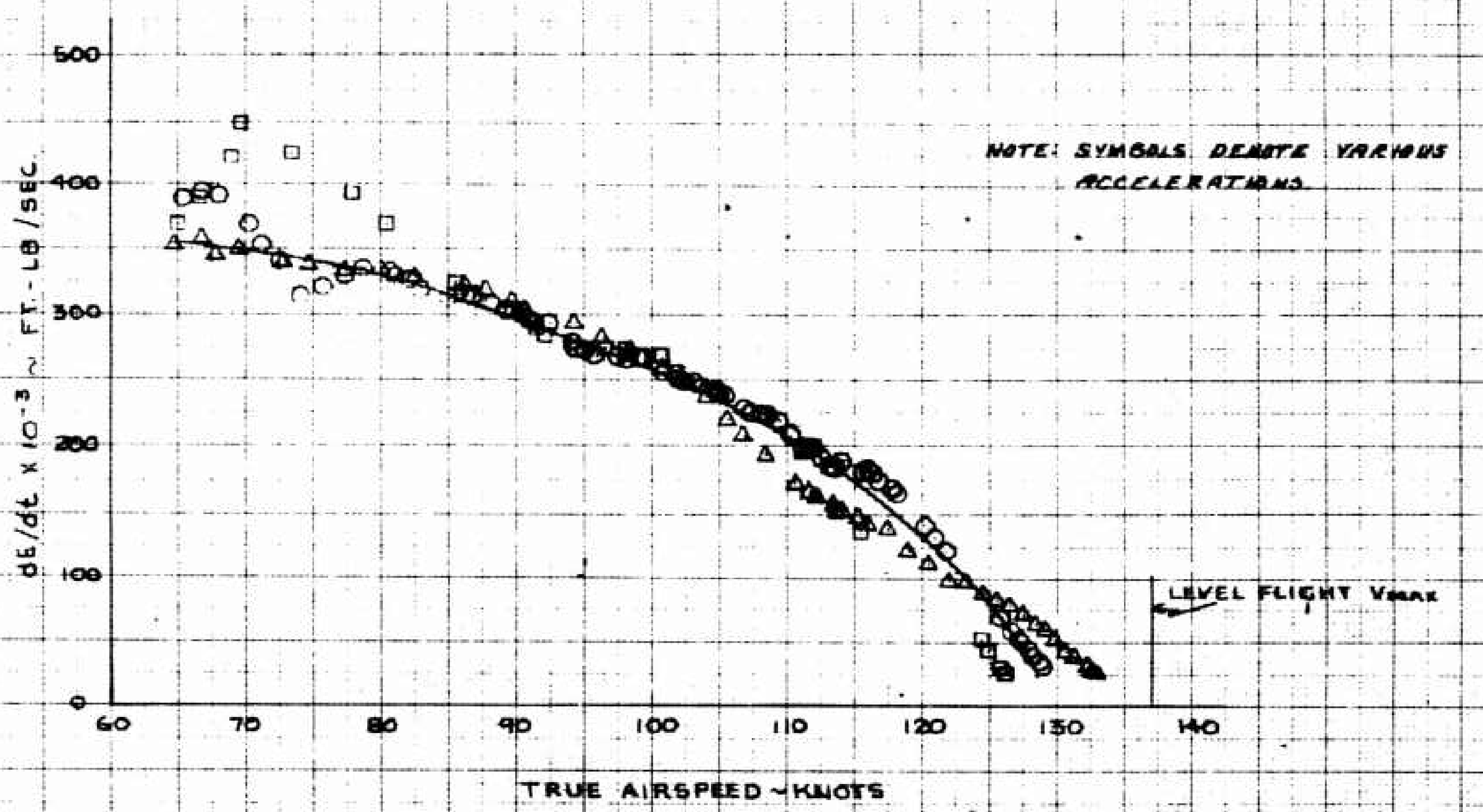


FIGURE No 20
LEVEL FLIGHT ACCELERATION
dE/dt VS VTRUE
UH-2B USN S/N 15-2202
C.G. STATION - 166.3 IN. (MID)
LDG. GEAR DOWN
SIMULATED TAT-141
TWO LAU 3A/A 19 ROUND PODS
WITHOUT NOSE CONES
7600 LB @ 5090 FT DENSITY ALTITUDE
7300 LB @ 1750 FT DENSITY ALTITUDE
LEVEL FLIGHT VMAX
7600 LB
dE/dt x 10⁻³ ~ FT-LB/SEC
0
100
200
300
400
500
40
50
60
70
80
90
100
110
120
130
140
TRUE AIRSPEED ~ KNOTS

FIGURE NO. 21
LEVEL FLIGHT ACCELERATION
dE/dt vs. V TRUE
UH-2B USN S/N 15-2202
C.G. STATION = 166.3 IN. (MID)
G.W. = 7600 LB AVG. ALT. = 3090 FT.
LDG. GEAR DOWN
SIMULATED T.A.T. = 141
TWO LAU 3A/A 19 ROUND PODS
WITHOUT NOSE CONES



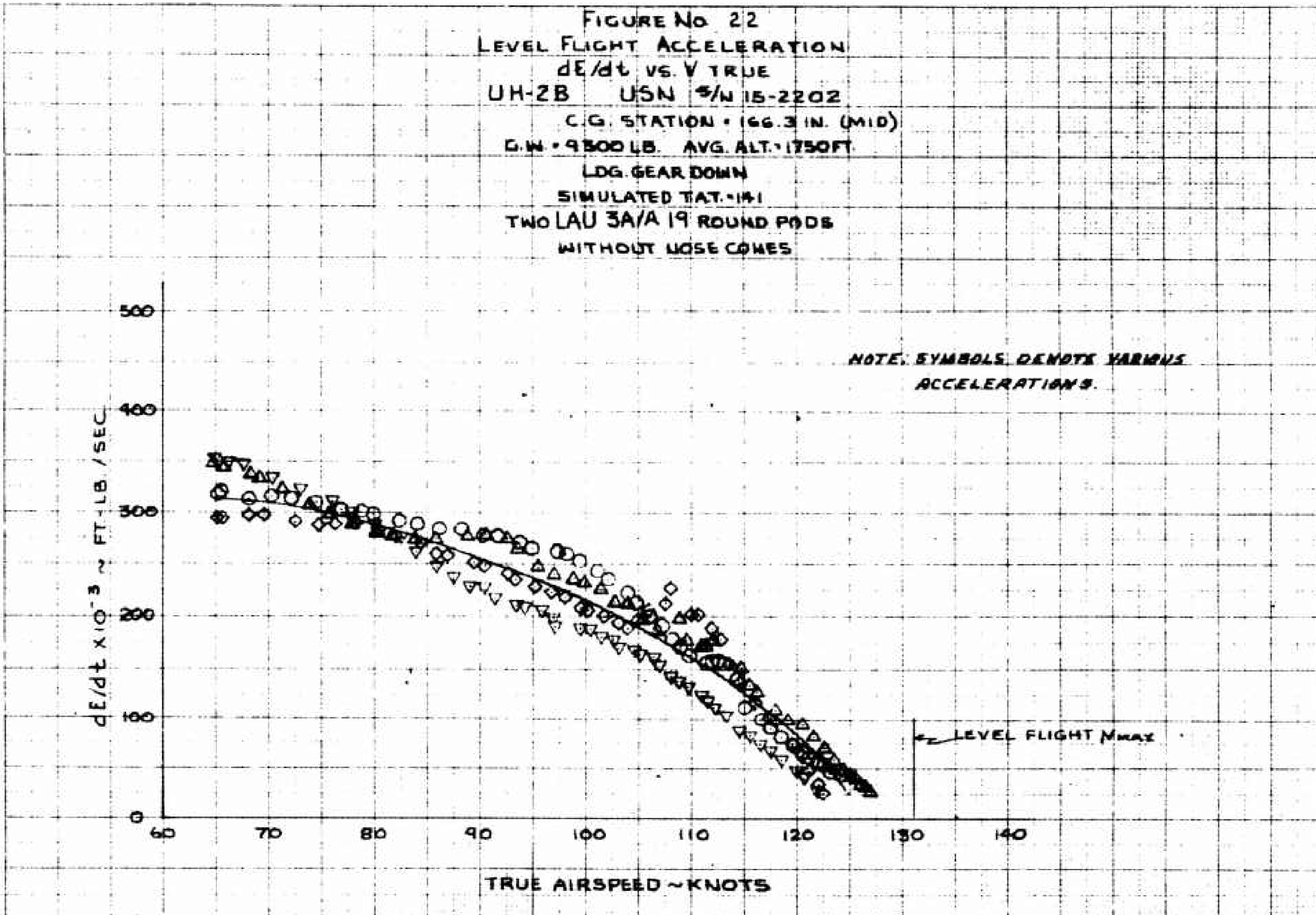


FIGURE No 22
LEVEL FLIGHT ACCELERATION
dE/dt VS. V TRUE
UH-2B USN S/N 15-2202
C.G. STATION = 166.3 IN. (MID)
G.W. = 9300 LB. AVG. ALT. = 1750 FT.
LDG. GEAR DOWN
SIMULATED TAT. = 141
TWO LAU 3A/A 19 ROUND PODS
WITHOUT NOSE CONES
NOTE: SYMBOLS DENOTE VARIOUS ACCELERATIONS.
LEVEL FLIGHT Vmax
dE/dt X10^-3 ~ FT-LB./SEC
0
100
200
300
400
500
60
70
80
90
100
110
120
130
140
TRUE AIRSPEED ~ KNOTS

FIGURE NO. 23
TURN REVERSALS
UH-2B USN S/N 15-2202
AVG GROSS WT = 8800LB. AVG C.G. STATION = 167 IN. (MID)
LDG. GEAR UP
SIMULATED T.A.T. = 141
TWO LAU/A19 ROUND PODS
WITHOUT NOSE CONES
AVG. DEN. ALT. = 2850 FT.

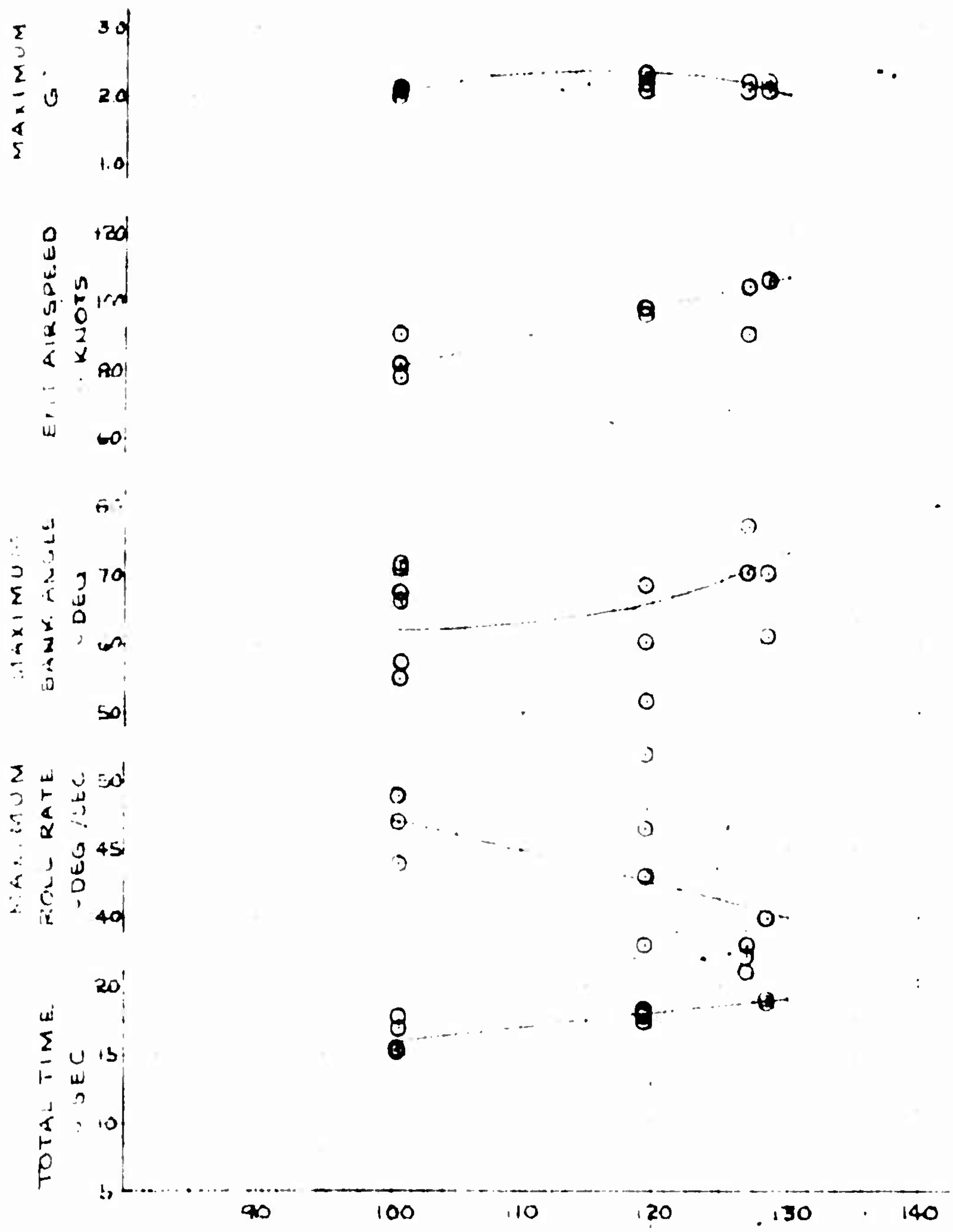


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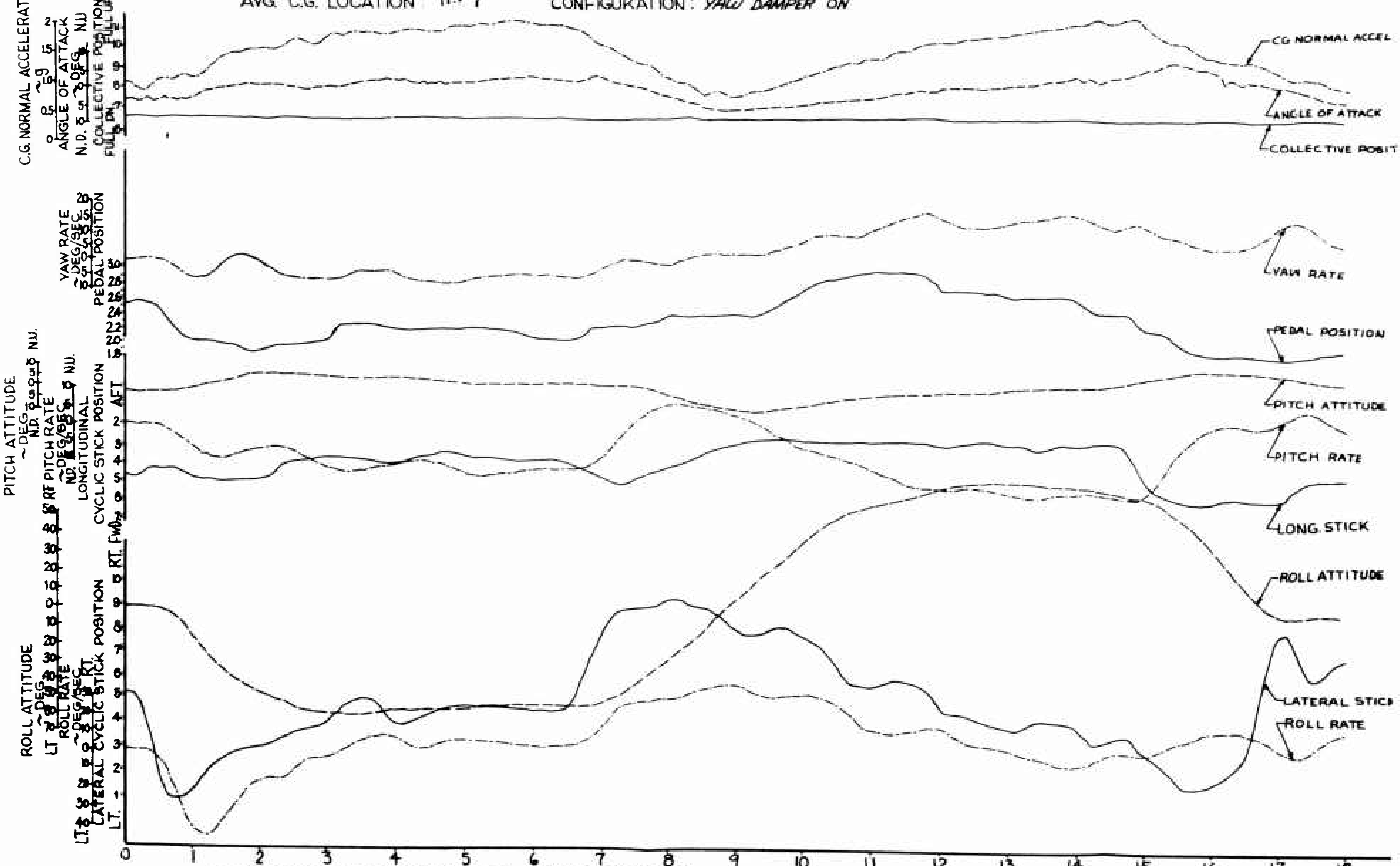
FIGURE NO. 24

TURN REVERSAL

UH-2B 15-2202

AVG. DENSITY ALTITUDE: 2780 FT AIRSPEED: 119.5 KTS CAS
AVG. GROSS WEIGHT: 8320 LB ROTOR RPM: 277
AVG. C.G. LOCATION: 1…7 CONFIGURATION: YAW DAMPER ON



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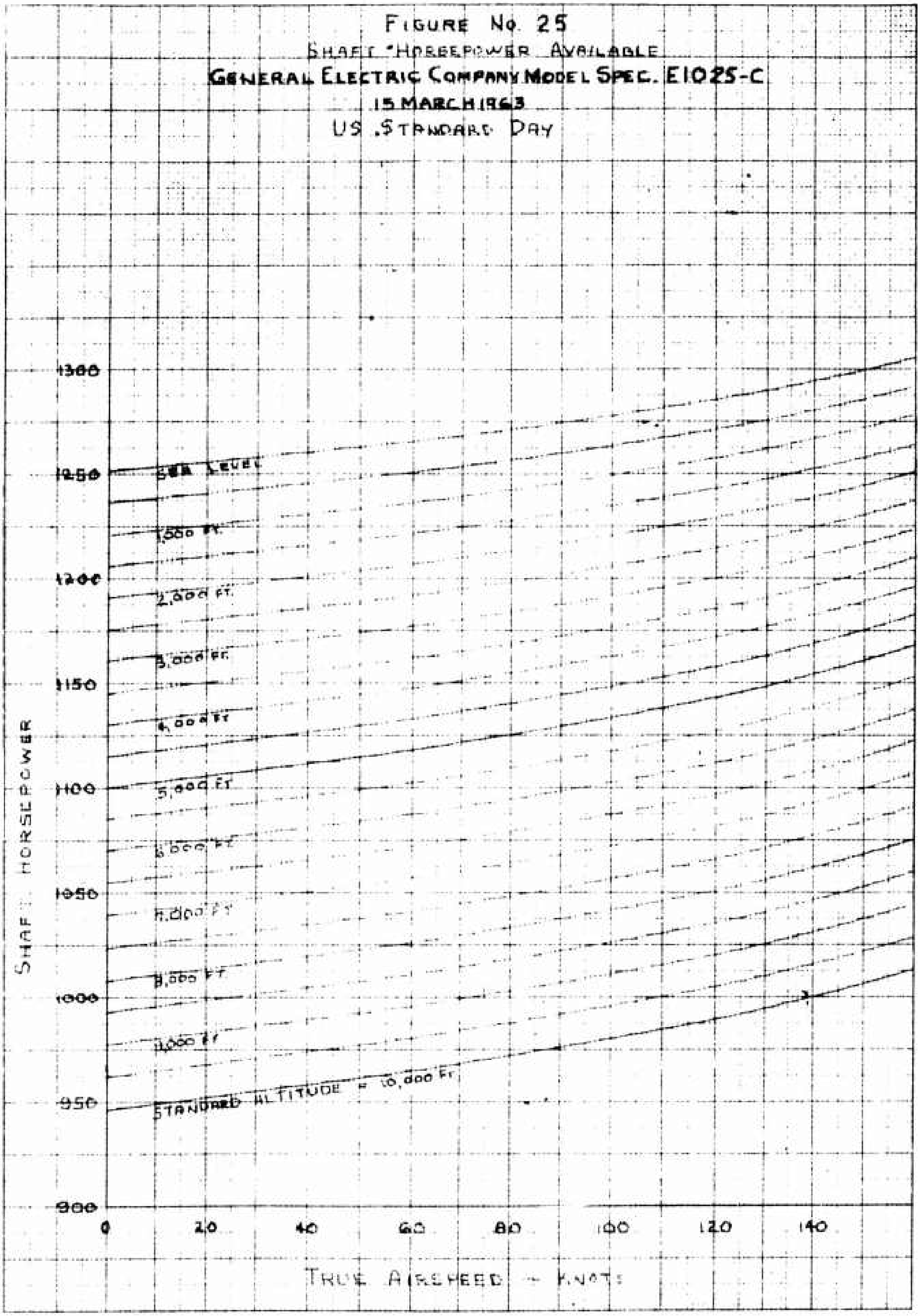
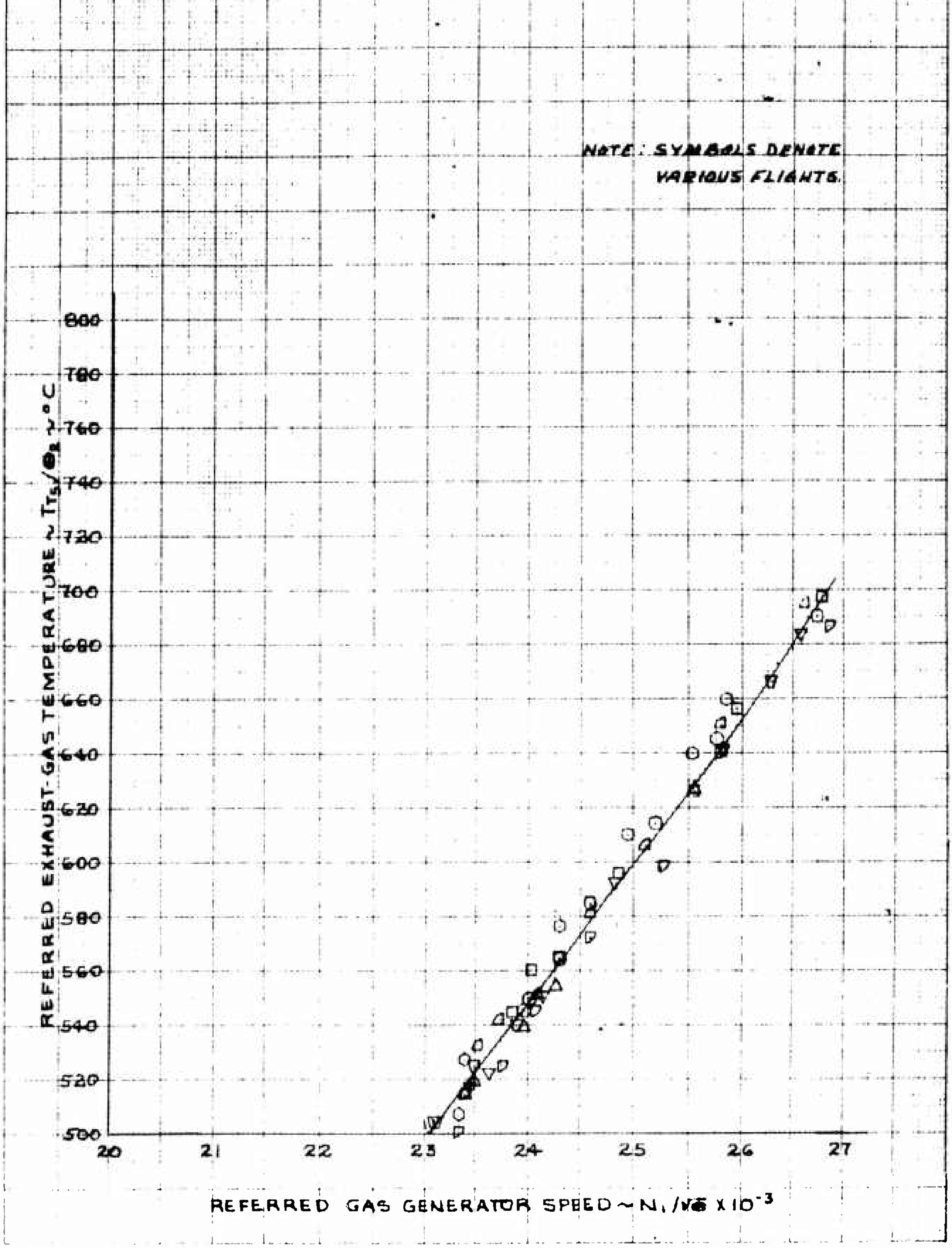


FIGURE No. 25
SHAFT HORSEPOWER AVAILABLE
GENERAL ELECTRIC COMPANY MODEL SPEC. E1025-C
15 MARCH 1963
US STANDARD DAY
1300
1250
1200
1150
1100
1050
1000
950
900
SEA LEVEL
1,000 FT.
2,000 FT.
3,000 FT.
4,000 FT.
5,000 FT.
6,000 FT.
7,000 FT.
8,000 FT.
9,000 FT.
STANDARD ALTITUDE = 10,000 FT.
SHAFT HORSEPOWER
0
20
40
60
80
100
120
140
TRUE AIRSPEED ~ KNOTS

FIGURE NO. 26
ENGINE CHARACTERISTICS
UH-2B USN S/N 152202
T58 - GE - 8 S/N 271 + 410



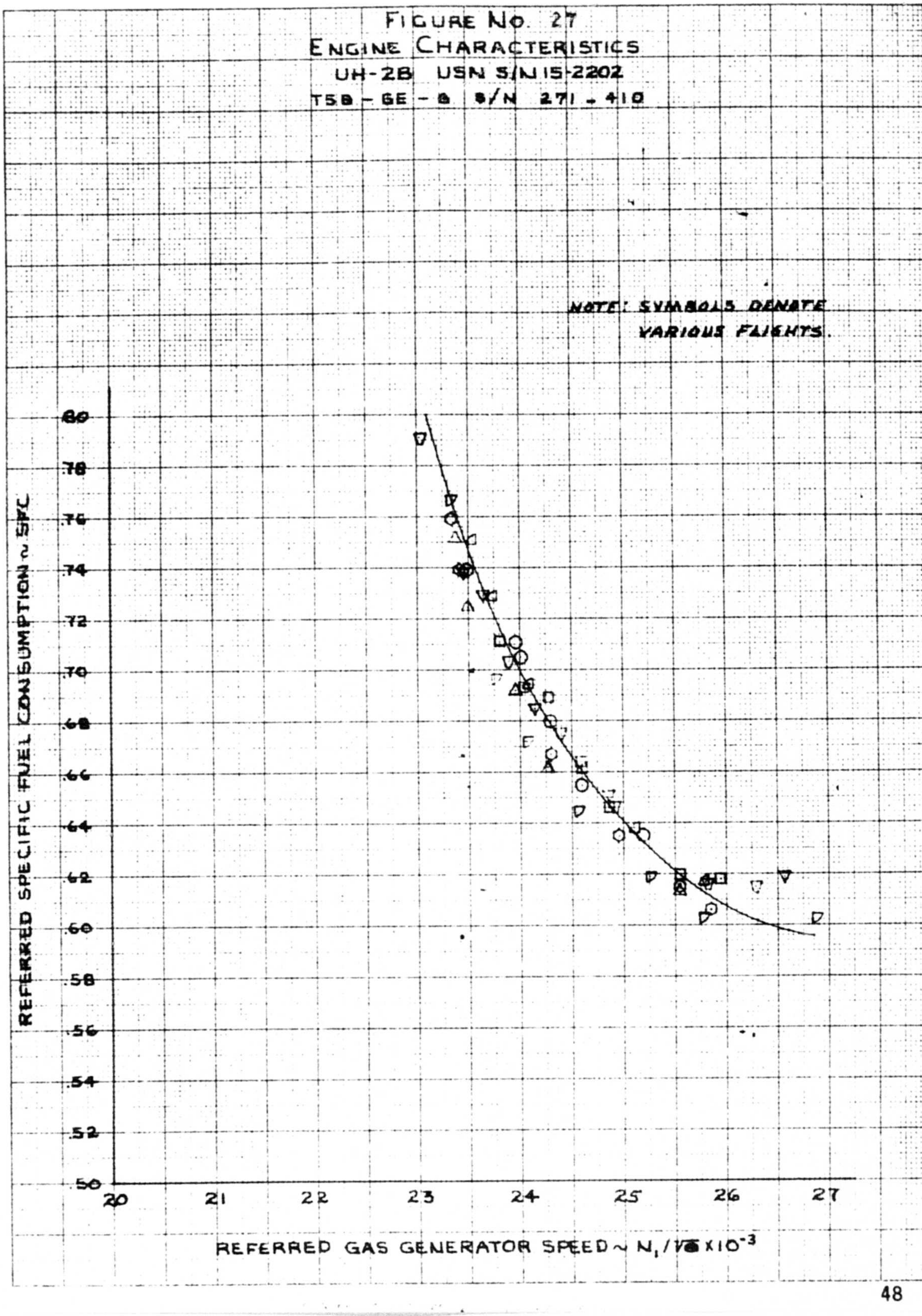


FIGURE No. 27
ENGINE CHARACTERISTICS
UH-2B USN S/N 15-2202
T58 - GE - 8 S/N 271 - 410
NOTE: SYMBOLS DENOTE VARIOUS FLIGHTS.
REFERRED SPECIFIC FUEL CONSUMPTION ~ SFC
.80
.78
.76
.74
.72
.70
.68
.66
.64
.62
.60
.58
.56
.54
.52
.50
20
21
22
23
24
25
26
27
REFERRED GAS GENERATOR SPEED ~ $N_1/\sqrt{\theta} \times 10^{-3}$

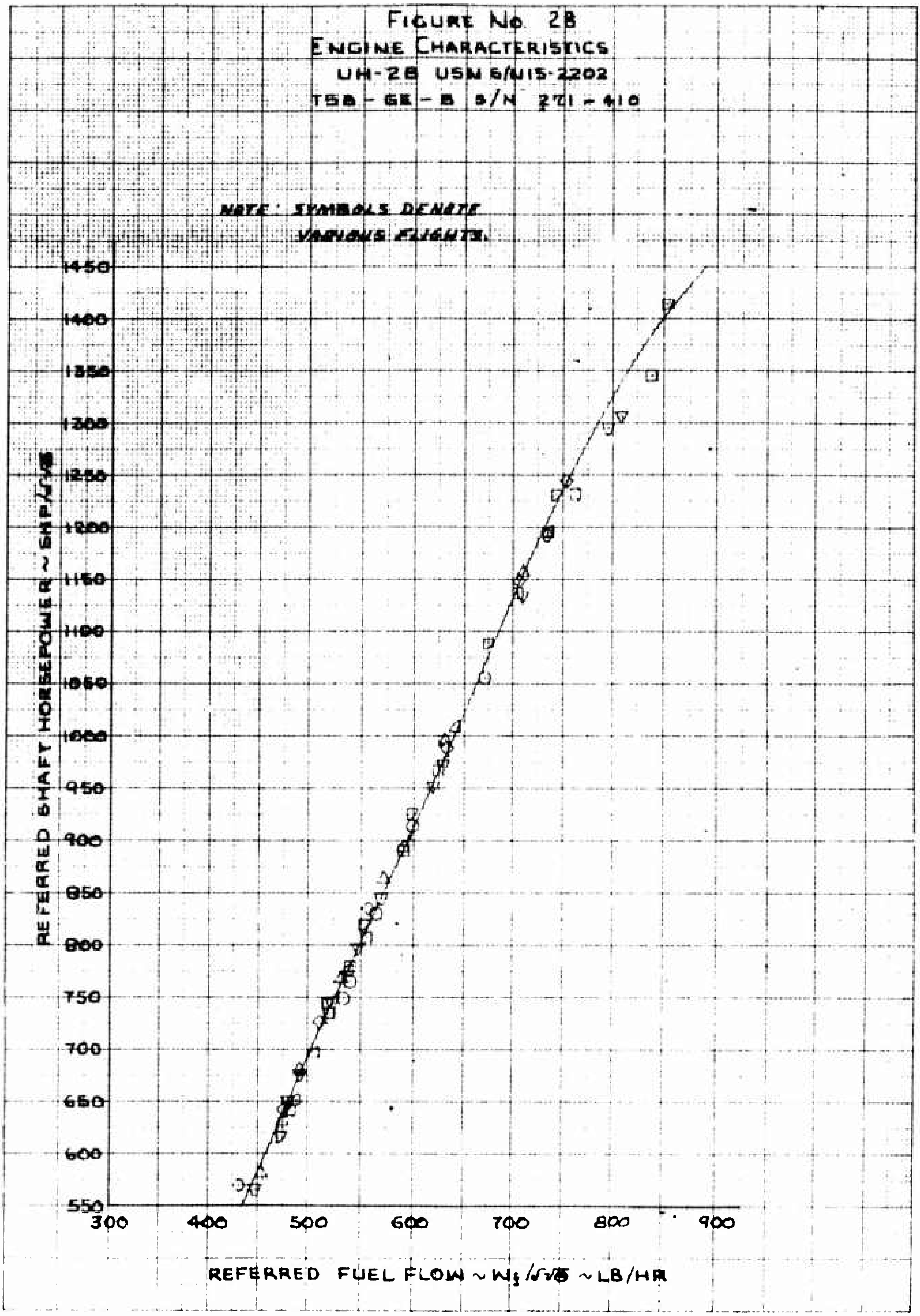


FIGURE No. 28
ENGINE CHARACTERISTICS
UH-2B USN 6/U15-2202
T58 - GE - 8 S/N 271 - 410
NOTE: SYMBOLS DENOTE VARIOUS FLIGHTS.
REFERRED SHAFT HORSEPOWER ~ SHP/δ√θ
1450
1400
1350
1300
1250
1200
1150
1100
1050
1000
950
900
850
800
750
700
650
600
550
300
400
500
600
700
800
900
REFERRED FUEL FLOW ~ $W_f/\delta\sqrt{\theta}$ ~ LB/HR

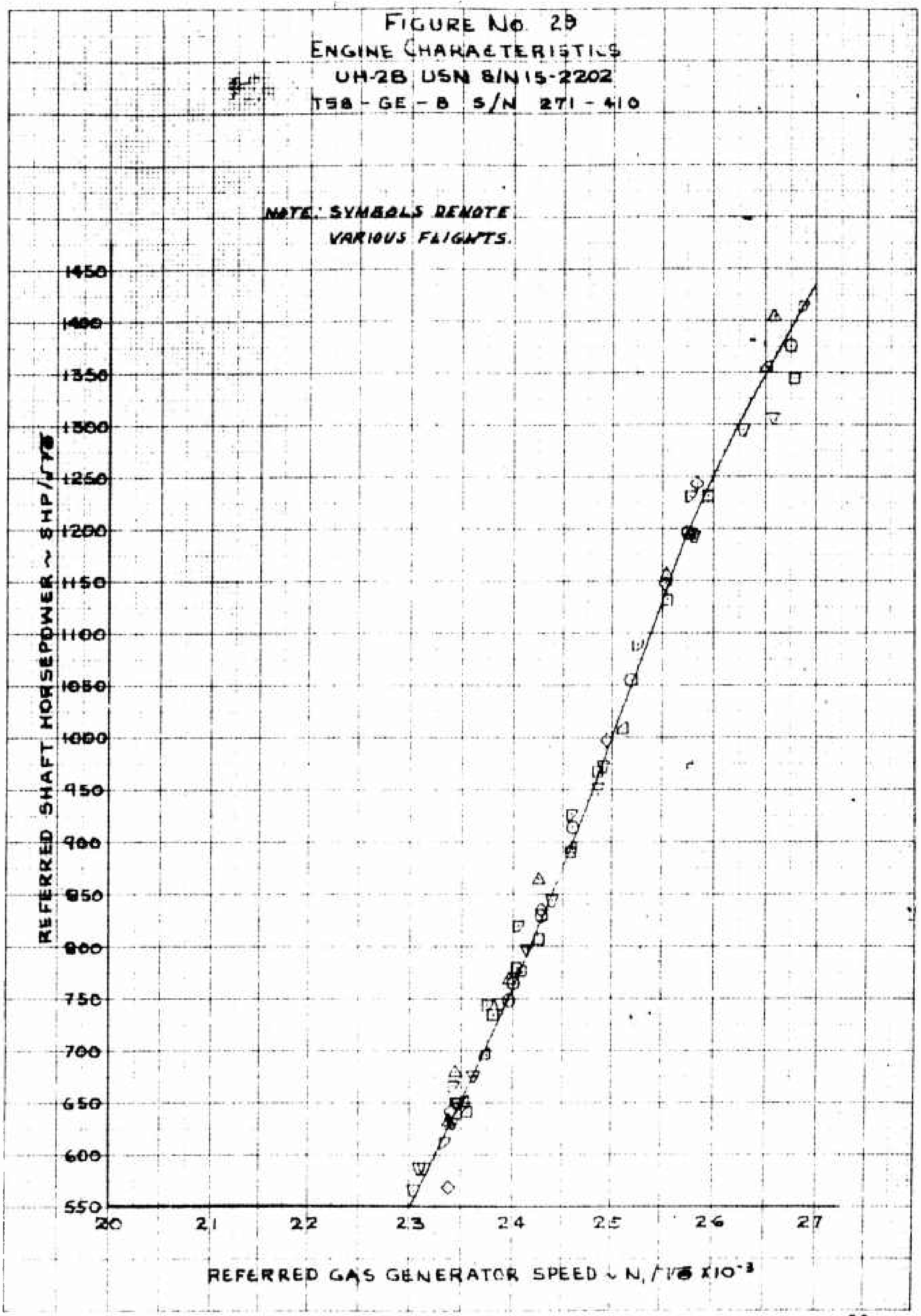


FIGURE No. 29
ENGINE CHARACTERISTICS
UH-2B USN S/N 15-2202
T58 - GE - 8 S/N 271 - 410
NOTE: SYMBOLS DENOTE
VARIOUS FLIGHTS.
REFERRED SHAFT HORSEPOWER ~ SHP/$\delta\sqrt{\theta}$
1450
1400
1350
1300
1250
1200
1150
1100
1050
1000
950
900
850
800
750
700
650
600
550
20
21
22
23
24
25
26
27
REFERRED GAS GENERATOR SPEED ~ $N_1/\sqrt{\theta}$ X10^{-3}

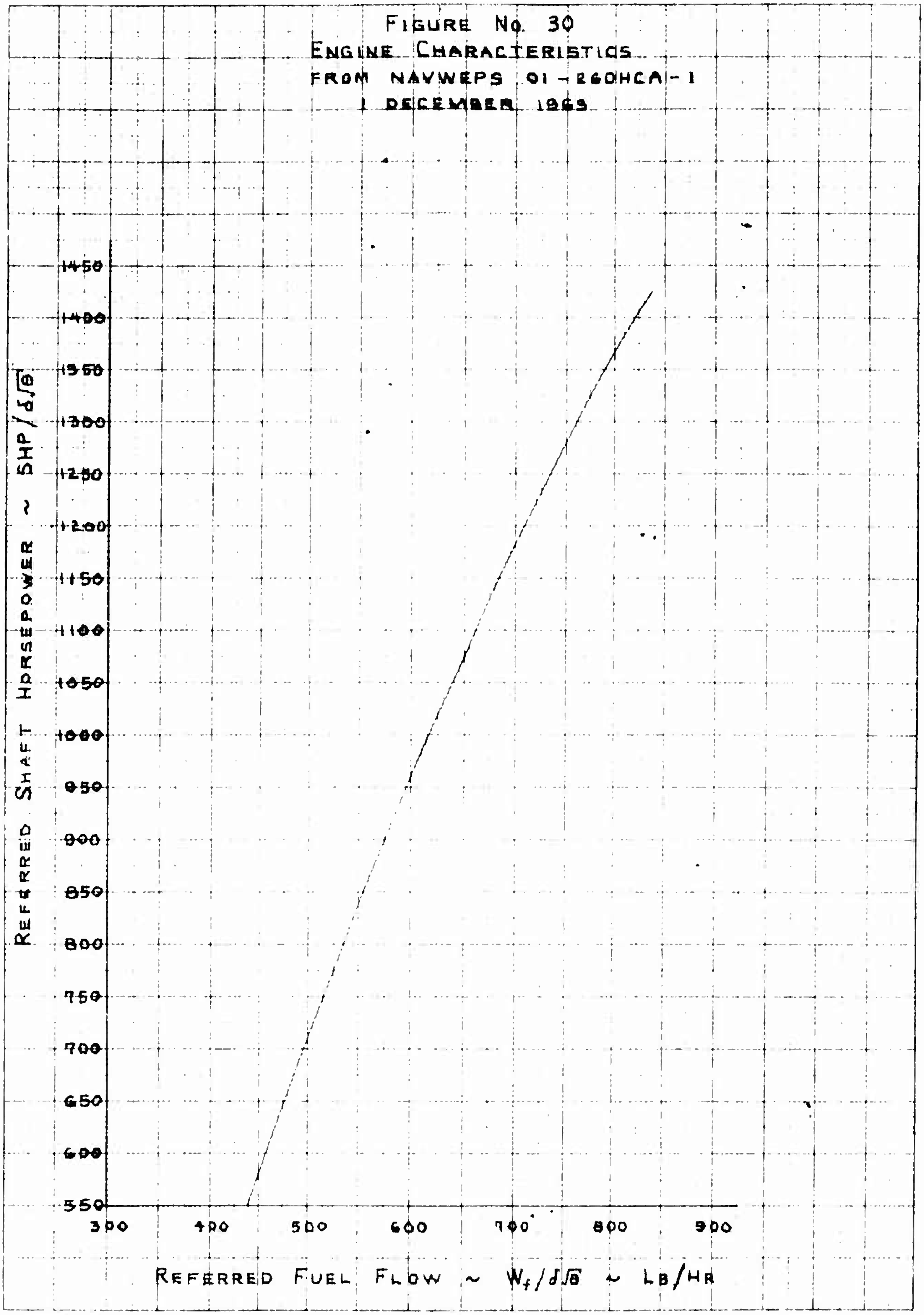


FIGURE No. 30
ENGINE CHARACTERISTICS
FROM NAVWEPS 01-260HCA-1
1 DECEMBER 1963
REFERRED SHAFT HORSEPOWER ~ SHP/δ√θ
1450
1400
1350
1300
1250
1200
1150
1100
1050
1000
950
900
850
800
750
700
650
600
550
300
400
500
600
700
800
900
REFERRED FUEL FLOW ~ $W_f/\delta\sqrt{\theta}$ ~ LB/HR

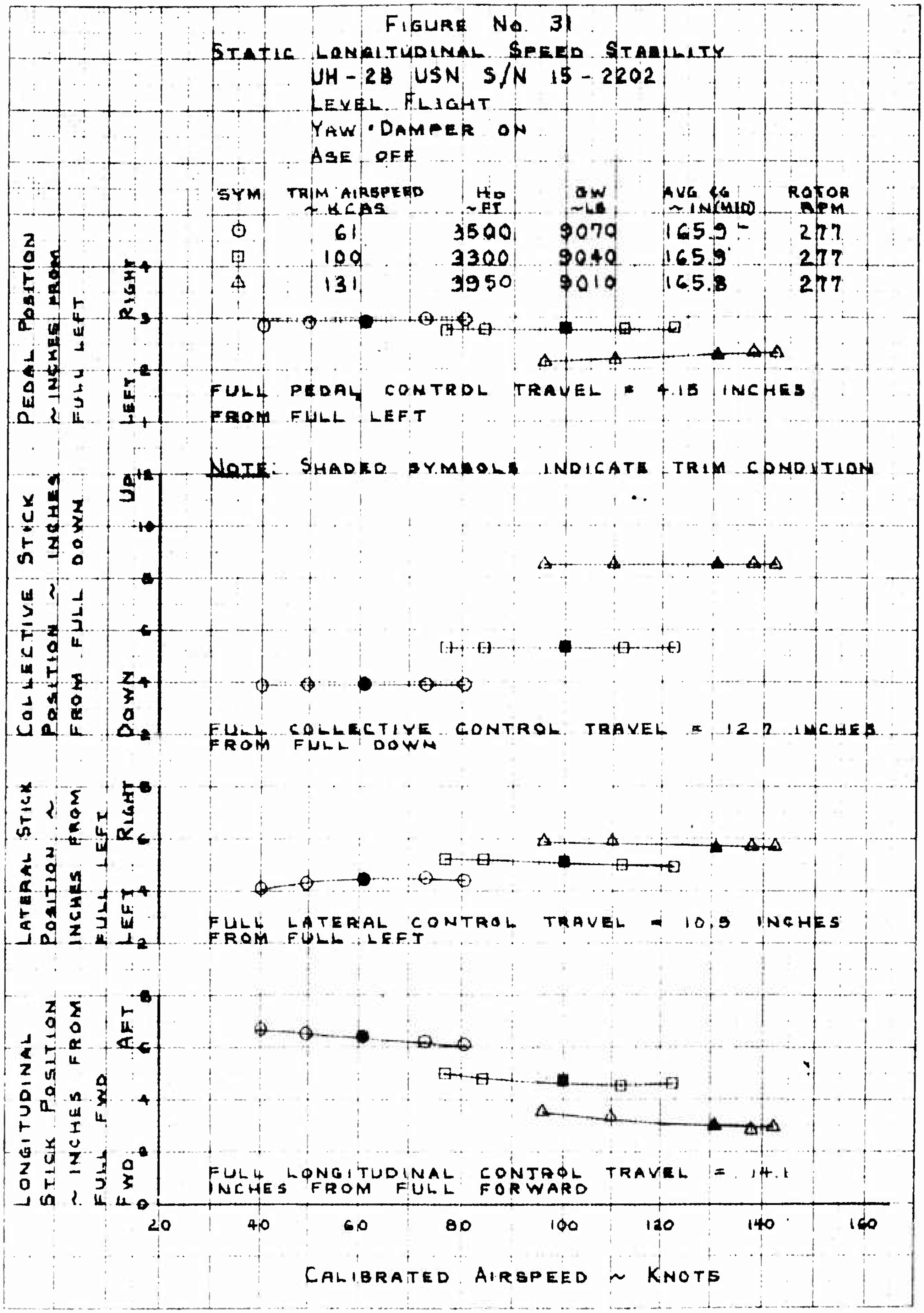


FIGURE NO. 31
STATIC LONGITUDINAL SPEED STABILITY
UH-2B USN S/N 15-2202
LEVEL FLIGHT
YAW DAMPER ON
ASE OFF
SYM
TRIM AIRSPEED ~ KCAS
Hp ~ FT
GW ~ LB
AVG CG ~ IN (MID)
ROTOR RPM
61
3500
9070
165.9
277
100
3300
9040
165.9
277
131
3950
9010
165.8
277
PEDAL POSITION ~ INCHES FROM FULL LEFT
LEFT
RIGHT
FULL PEDAL CONTROL TRAVEL = 4.15 INCHES FROM FULL LEFT
NOTE: SHADED SYMBOLS INDICATE TRIM CONDITION
COLLECTIVE STICK POSITION ~ INCHES FROM FULL DOWN
UP
DOWN
FULL COLLECTIVE CONTROL TRAVEL = 12.7 INCHES FROM FULL DOWN
LATERAL STICK POSITION ~ INCHES FROM FULL LEFT
LEFT
RIGHT
FULL LATERAL CONTROL TRAVEL = 10.5 INCHES FROM FULL LEFT
LONGITUDINAL STICK POSITION ~ INCHES FROM FULL FWD
FWD
AFT
FULL LONGITUDINAL CONTROL TRAVEL = 14.1 INCHES FROM FULL FORWARD
20
40
60
80
100
120
140
160
CALIBRATED AIRSPEED ~ KNOTS

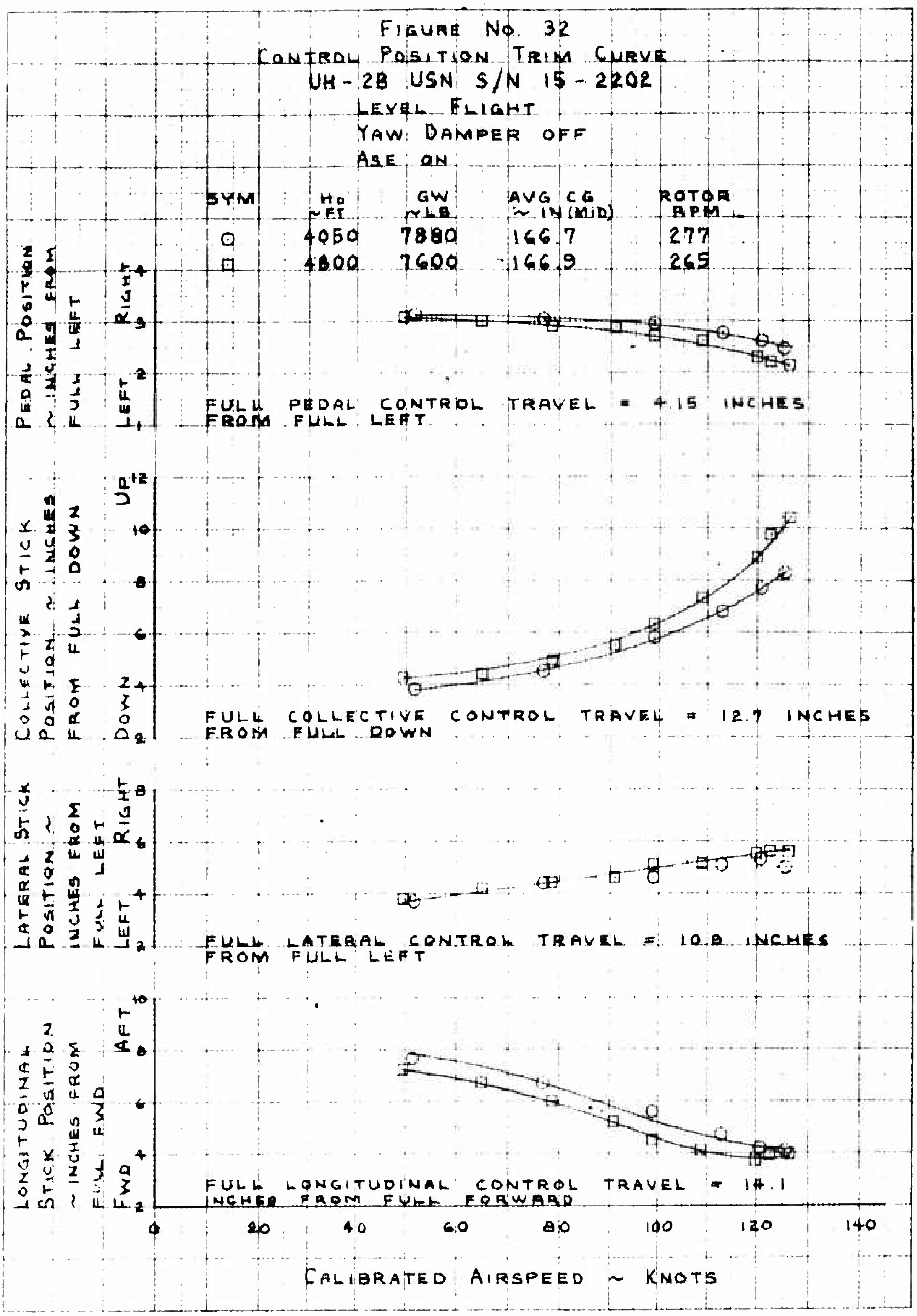
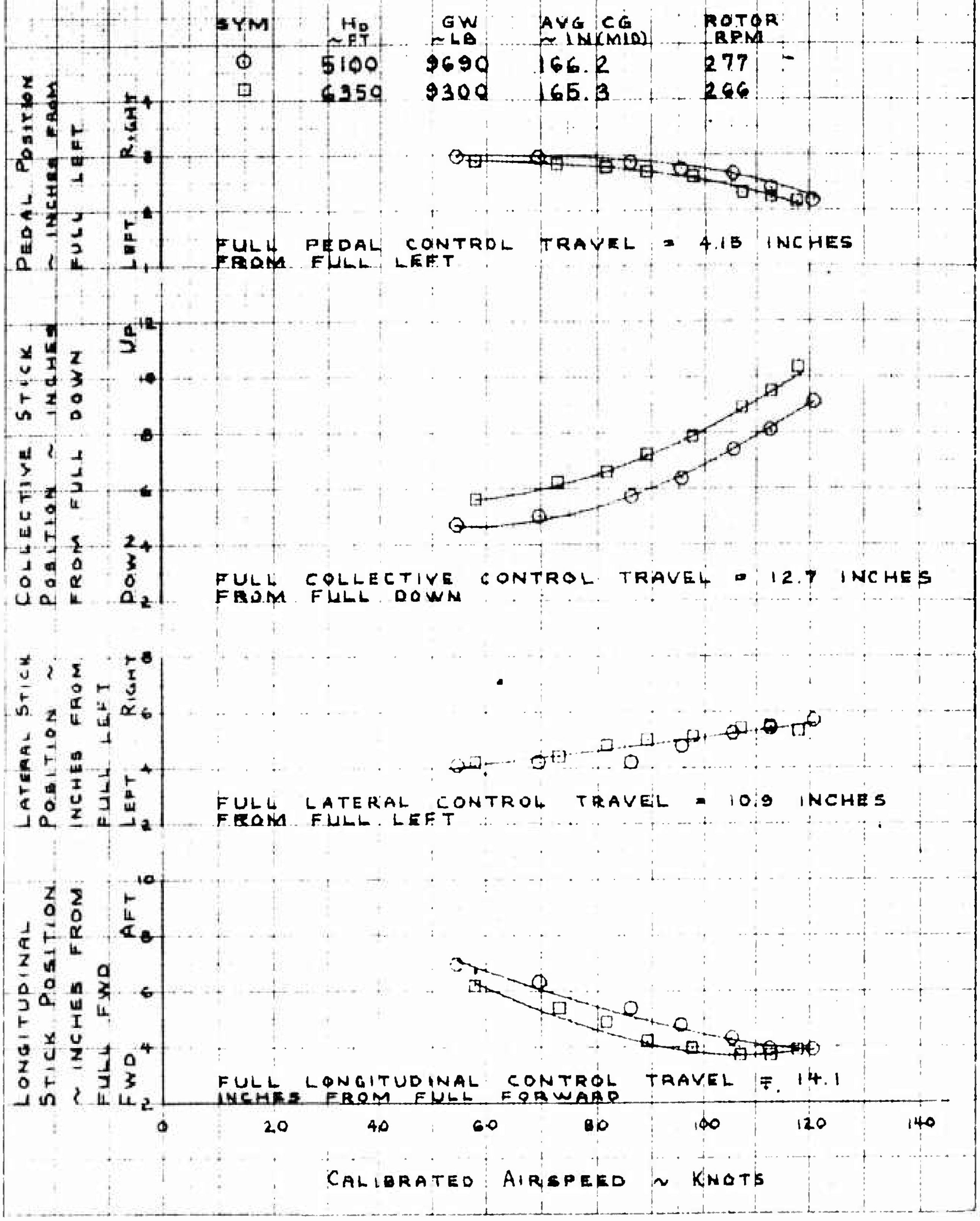


FIGURE No. 32
CONTROL POSITION TRIM CURVE
UH-2B USN S/N 15-2202
LEVEL FLIGHT
YAW DAMPER OFF
ASE ON
SYM | Ho ~FT | GW ~LB | AVG CG ~ IN (MID) | ROTOR RPM
○ | 4050 | 7880 | 166.7 | 277
□ | 4800 | 7600 | 166.9 | 265
PEDAL POSITION ~ INCHES FROM FULL LEFT
LEFT
RIGHT
FULL PEDAL CONTROL TRAVEL = 4.15 INCHES FROM FULL LEFT
COLLECTIVE STICK POSITION ~ INCHES FROM FULL DOWN
DOWN
UP
FULL COLLECTIVE CONTROL TRAVEL = 12.7 INCHES FROM FULL DOWN
LATERAL STICK POSITION ~ INCHES FROM FULL LEFT
LEFT
RIGHT
FULL LATERAL CONTROL TRAVEL = 10.9 INCHES FROM FULL LEFT
LONGITUDINAL STICK POSITION ~ INCHES FROM FULL FWD
FWD
AFT
FULL LONGITUDINAL CONTROL TRAVEL = 14.1 INCHES FROM FULL FORWARD
0
20
40
60
80
100
120
140
CALIBRATED AIRSPEED ~ KNOTS

FIGURE No. 33
CONTROL POSITION TRIM CURVE
UH-2B USN S/N 15-2202
LEVEL FLIGHT
YAW DAMPER OFF
ASE ON



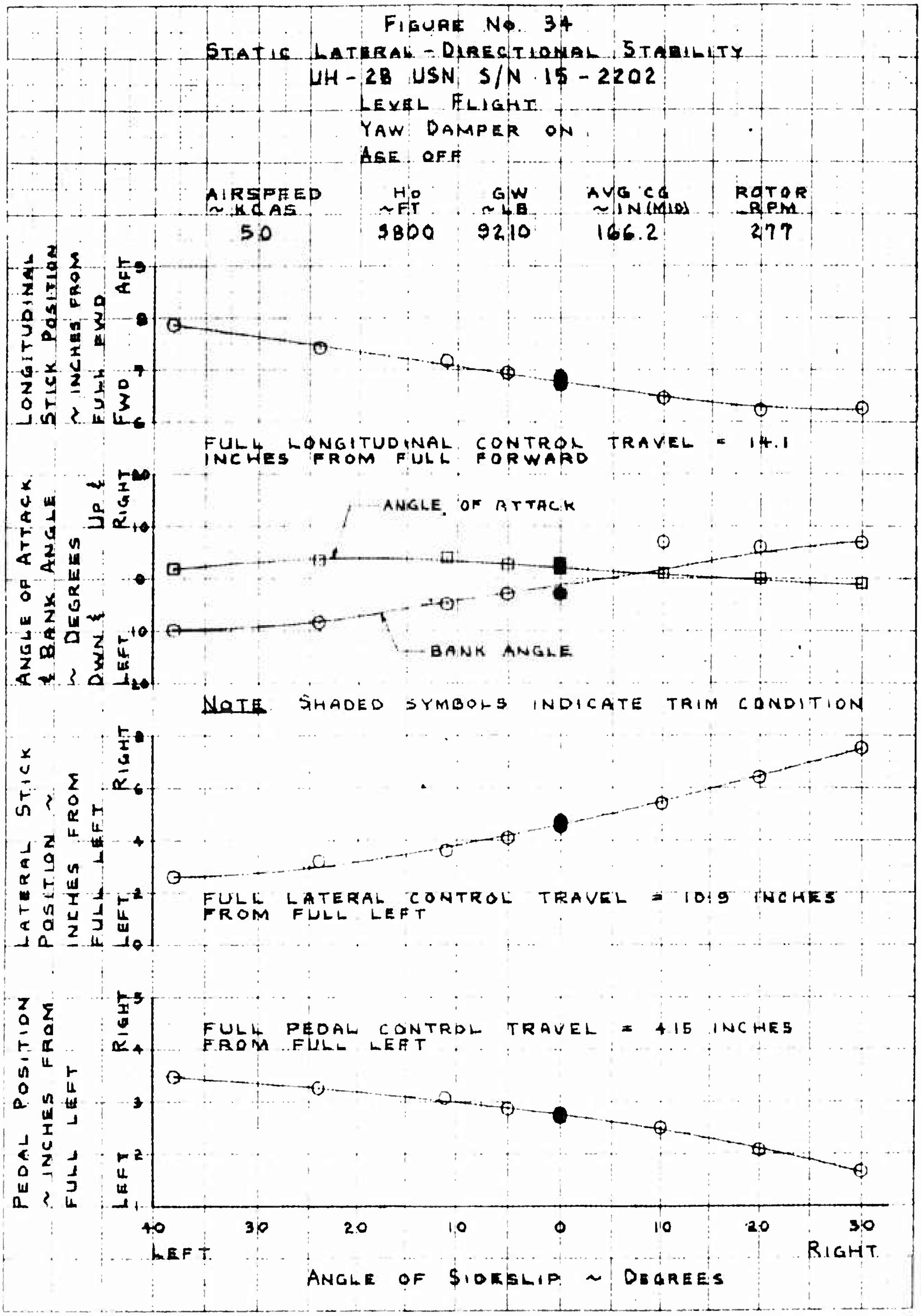
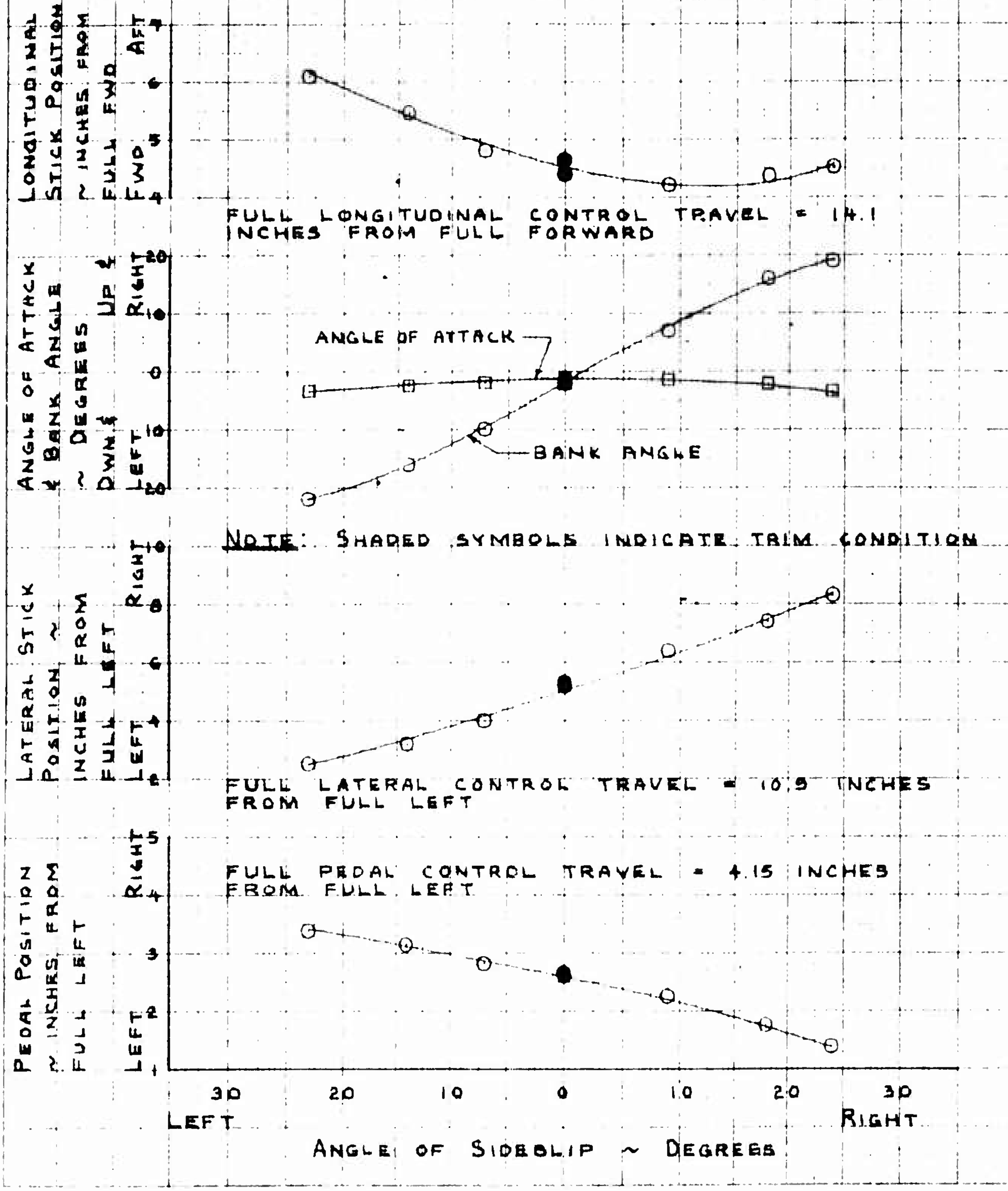


FIGURE No. 34
STATIC LATERAL - DIRECTIONAL STABILITY
UH-2B USN S/N 15-2202
LEVEL FLIGHT
YAW DAMPER ON
ASE OFF
AIRSPEED ~ KCAS
50
Hp ~FT
5800
G.W ~LB
9210
AVG CG ~IN(MID)
166.2
ROTOR RPM
277
LONGITUDINAL STICK POSITION ~ INCHES FROM FULL FWD
FWD
AFT
FULL LONGITUDINAL CONTROL TRAVEL = 14.1 INCHES FROM FULL FORWARD
ANGLE OF ATTACK & BANK ANGLE ~ DEGREES
DWN & LEFT
UP & RIGHT
ANGLE OF ATTACK
BANK ANGLE
NOTE SHADED SYMBOLS INDICATE TRIM CONDITION
LATERAL STICK POSITION ~ INCHES FROM FULL LEFT
LEFT
RIGHT
FULL LATERAL CONTROL TRAVEL = 10.5 INCHES FROM FULL LEFT
PEDAL POSITION ~ INCHES FROM FULL LEFT
LEFT
RIGHT
FULL PEDAL CONTROL TRAVEL = 4.15 INCHES FROM FULL LEFT
40
30
20
10
0
10
20
30
LEFT
RIGHT
ANGLE OF SIDESLIP ~ DEGREES

FIGURE NO. 35
STATIC LATERAL - DIRECTIONAL STABILITY
UH-2B USN S/N 15-2202
LEVEL FLIGHT
YAW DAMPER ON
ASE OFF

AIRSPEED ~KCAS	Hp ~FT	GW ~LB	AVG CG ~IN (MID)	ROTOR RPM
100	3800	9240	166.3	277



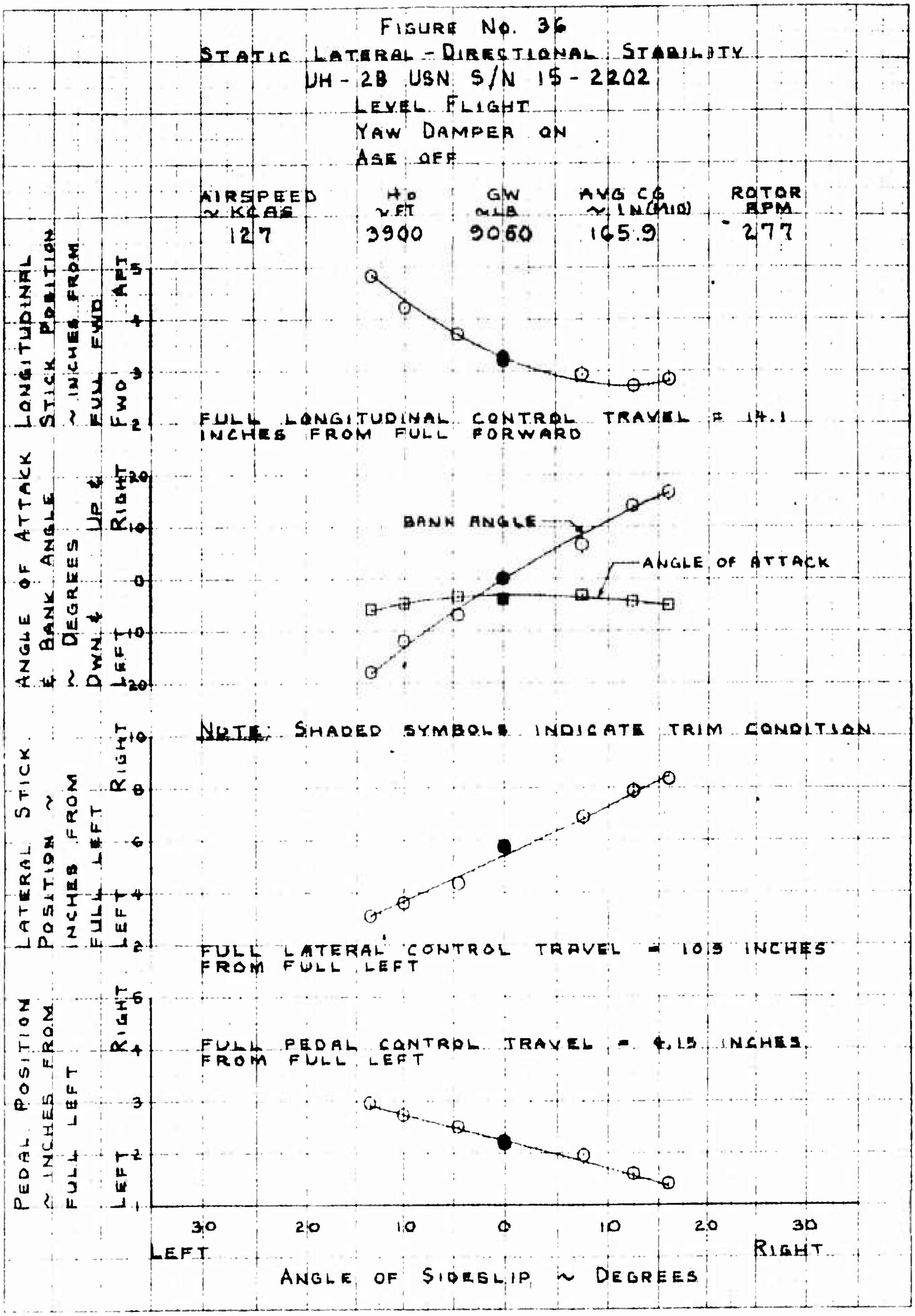


FIGURE No. 36
STATIC LATERAL - DIRECTIONAL STABILITY
UH - 2B USN S/N 15 - 2202
LEVEL FLIGHT
YAW DAMPER ON
ASE OFF
AIRSPEED ~ KCAS
127
Hp ~ FT
3900
GW ~ LB
9060
AVG CG ~ IN (MID)
165.9
ROTOR RPM
277
LONGITUDINAL STICK POSITION ~ INCHES FROM FULL FWD
FWD
AFT
FULL LONGITUDINAL CONTROL TRAVEL = 14.1 INCHES FROM FULL FORWARD
ANGLE OF ATTACK & BANK ANGLE ~ DEGREES
DWN & LEFT
UP & RIGHT
BANK ANGLE
ANGLE OF ATTACK
NOTE: SHADED SYMBOLS INDICATE TRIM CONDITION
LATERAL STICK POSITION ~ INCHES FROM FULL LEFT
LEFT
RIGHT
FULL LATERAL CONTROL TRAVEL = 10.5 INCHES FROM FULL LEFT
PEDAL POSITION ~ INCHES FROM FULL LEFT
LEFT
RIGHT
FULL PEDAL CONTROL TRAVEL = 4.15 INCHES FROM FULL LEFT
30
20
10
0
10
20
30
LEFT
RIGHT
ANGLE OF SIDESLIP ~ DEGREES

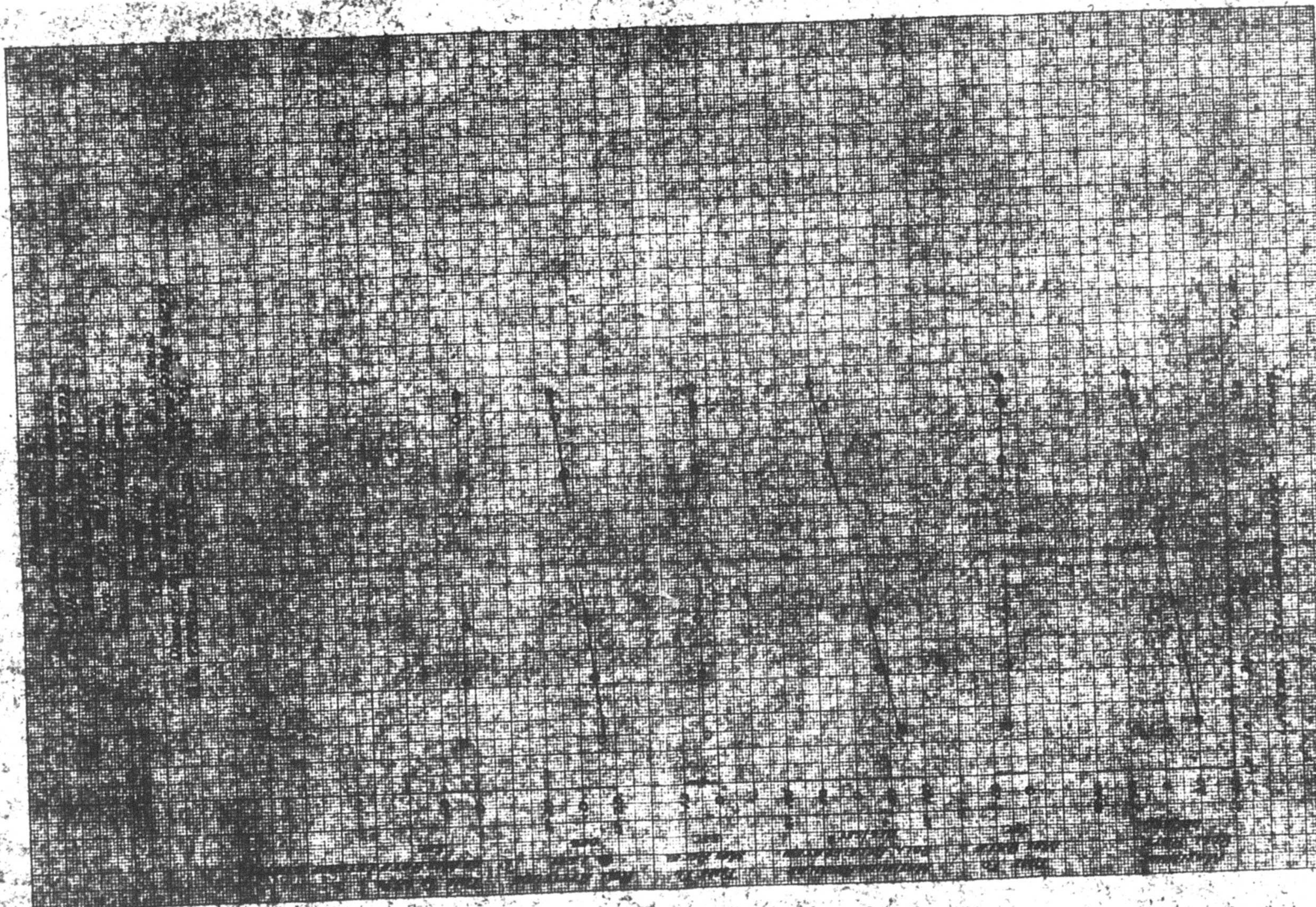


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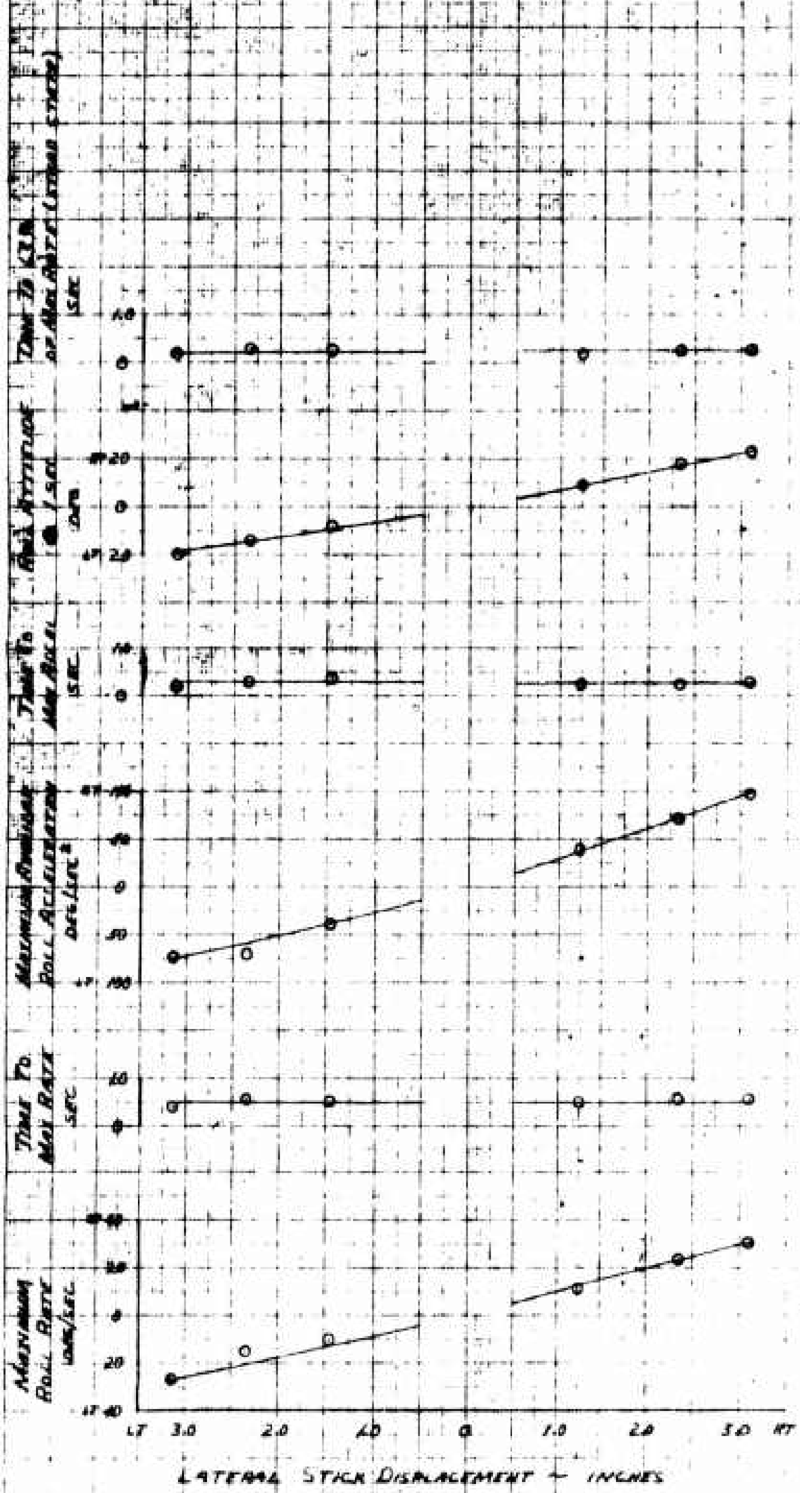
FIGURE NO. 38
LATERAL CONTROLLABILITY
UH-2B USN S/N 15-2202
SIMULATED TAT 141
TWO LAU 3A/A 19 ROUND
PODS WITHOUT NOSE CONES
GEAR UP
C.G. STATION = 166.3 IN. (MID)
DENSITY ALT. = 3500 FT. ROTOR RPM = 277
G.W. = 9280 LB 100 KTS CAS ASE "OFF"



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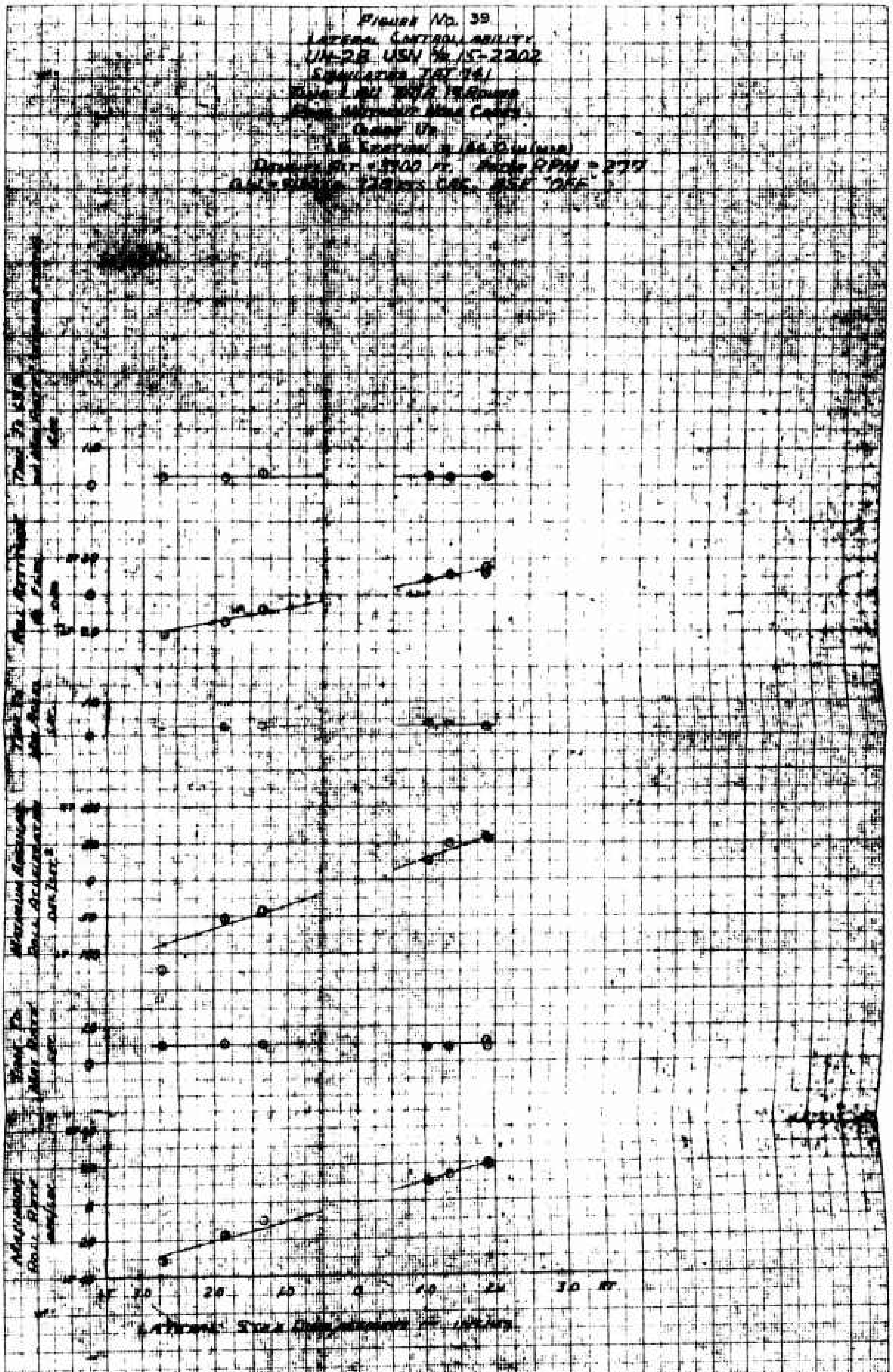

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FIGURE NO. 40

LEFT LATERAL STEP

UH-2B 15-2202

AVG. DENSITY ALTITUDE: 5000 FT. AIRSPEED: 131 KTS. CAS
AVG. GROSS WEIGHT: 9400 LB. ROTOR RPM: 277
AVG. C.G. LOCATION: 166.1 CONFIGURATION: YAW DAMPER ON, ASE OFF

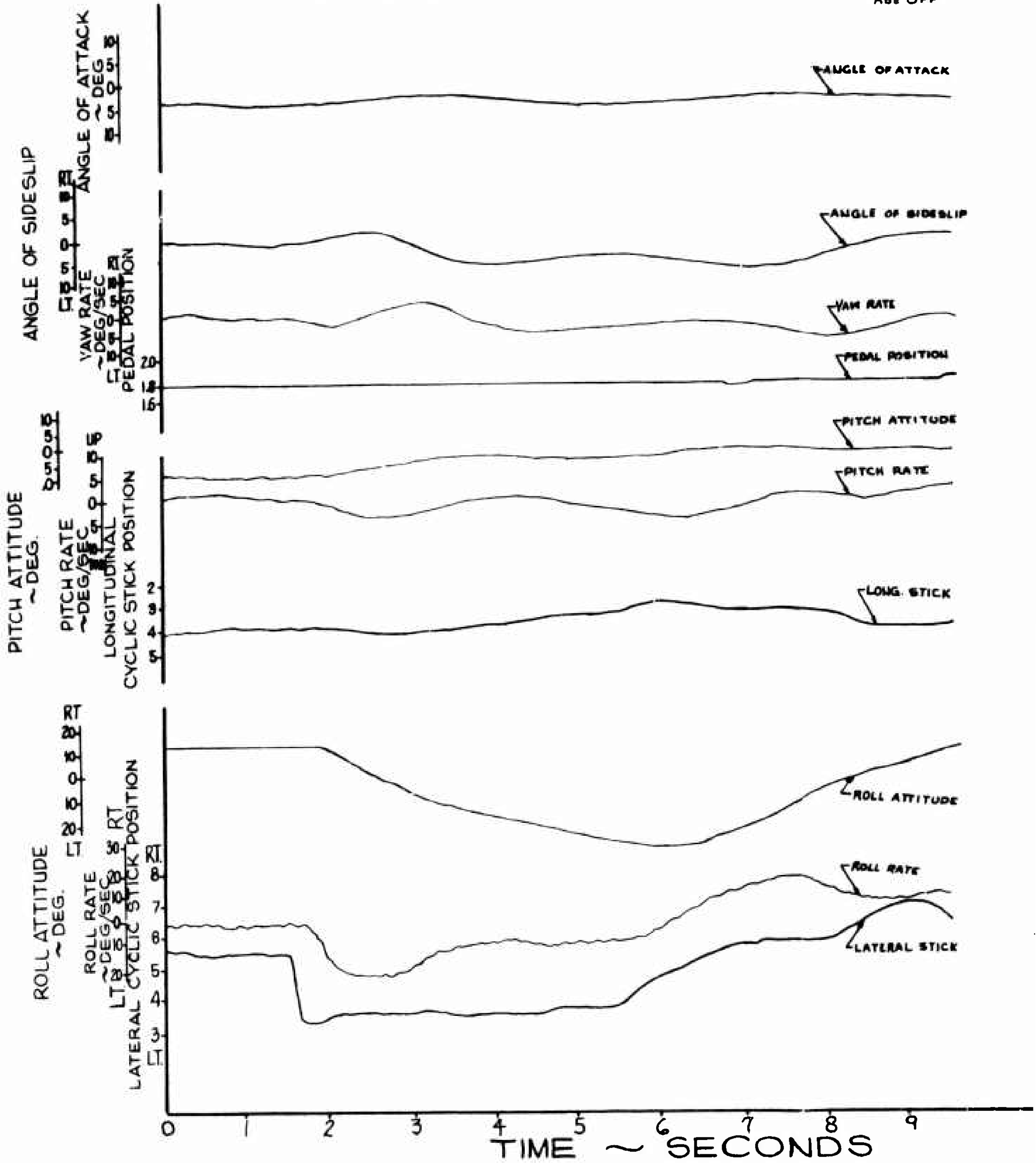

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FIGURE No. 41
MANEUVERING STABILITY
UH-2B USN S/N 15-2202
AVG. GROSS WT. 7900 LB. ROTOR RPM 277
AVG. DENSITY ALT. 3000 FT.
AVG. CG STA. 166.8 IN. (MID)

SYMMETRICAL PULL-UPS

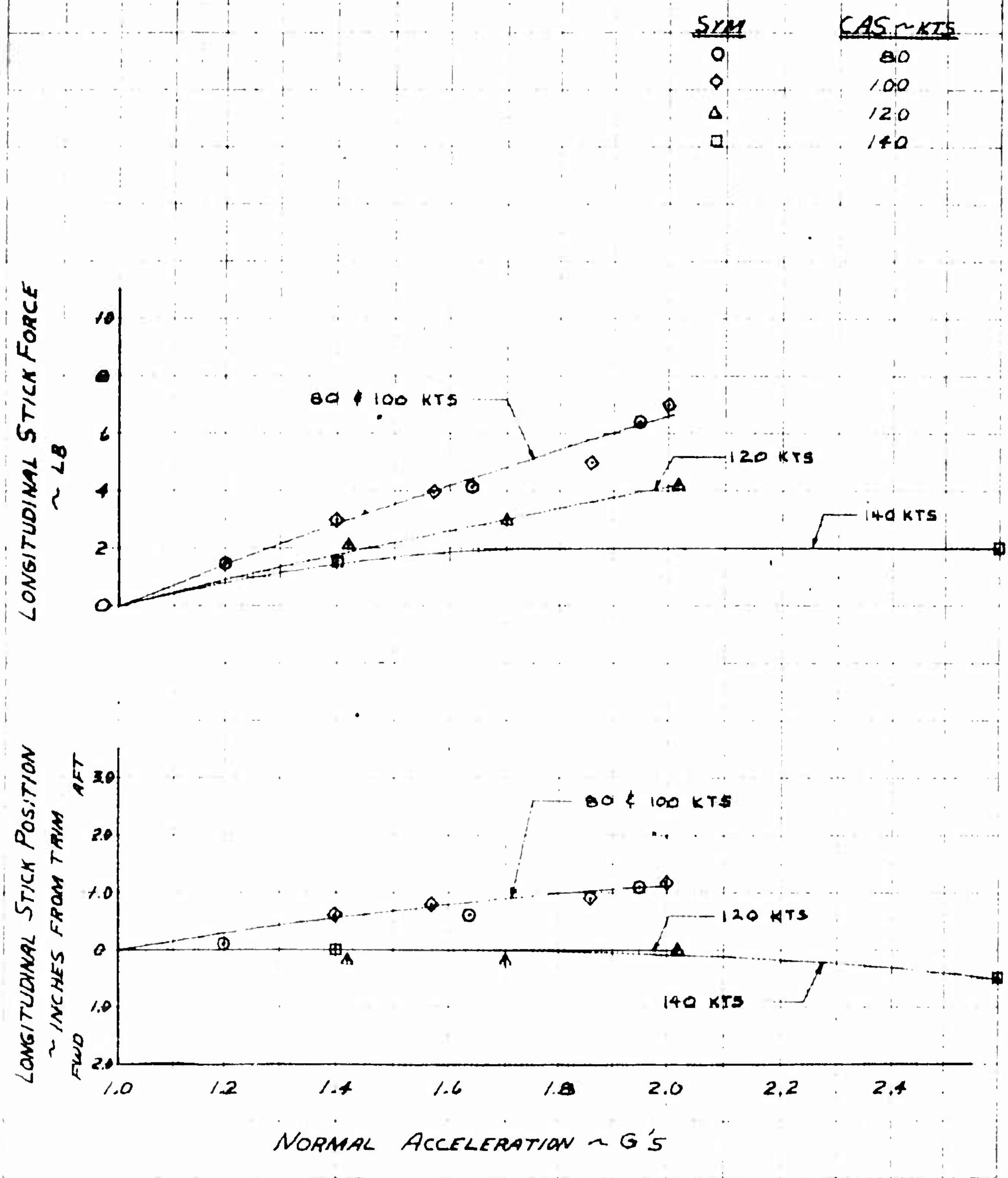

FIGURE No. 42
MANEUVERING STABILITY
UH-2B USN S/N 15-2202
AVG. GROSS WT. 9130 LB. ROTOR RPM 277
AVG DENSITY ALT. 4000 FT.
AVG C.G. STA. 166.3 IN. (MID)

SYMMETRICAL PULL-UPS

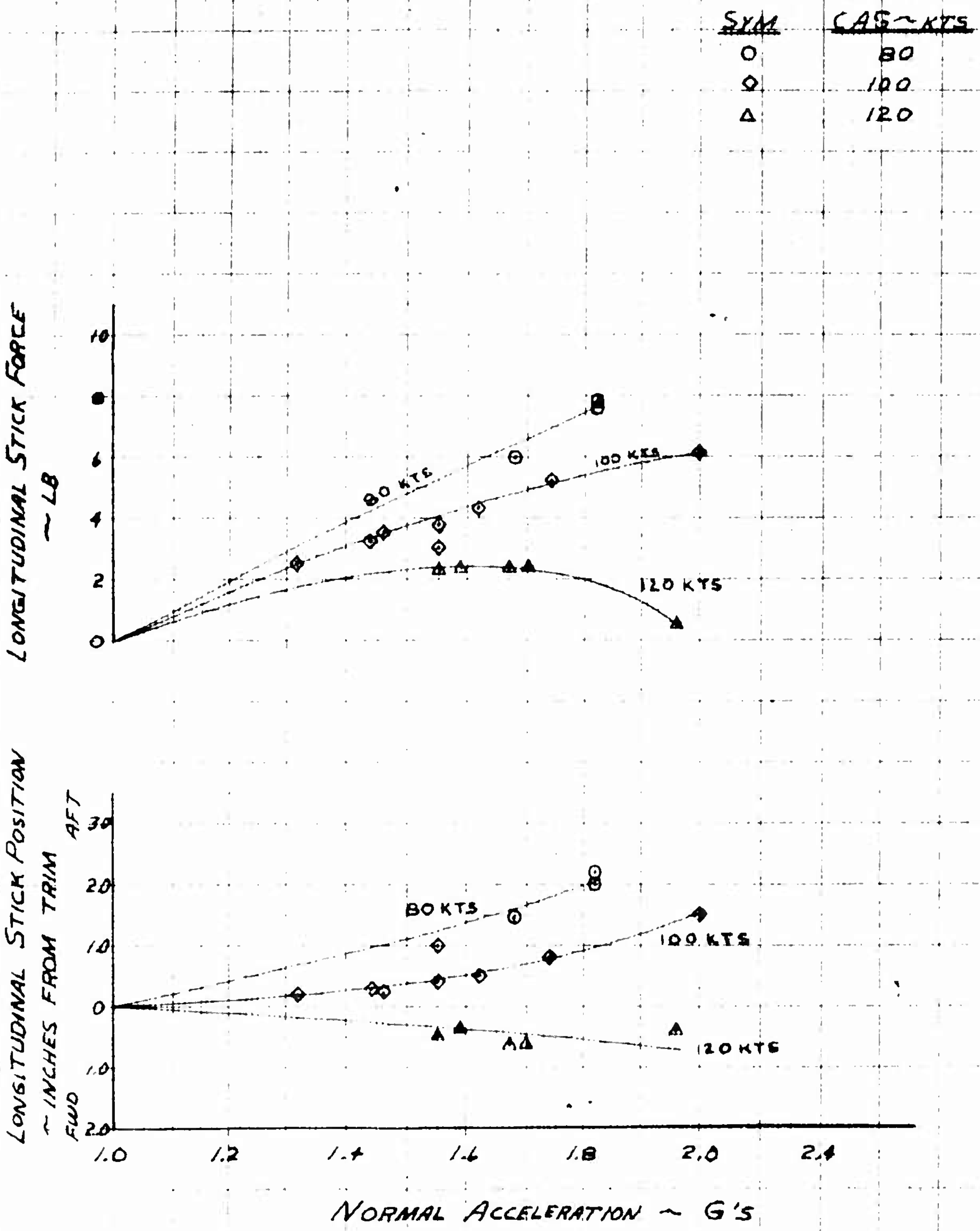

FIGURE NO. 43

AFT LONGITUDINAL STEP

UH-2B 15-2202

AVG. DENSITY ALTITUDE: 3930 FT AIRSPEED: 119.5 KTS CAS

AVG. GROSS WEIGHT 8850 LB ROTOR RPM: 277

AVG. C.G. LOCATION: 165.4 IN CONFIGURATION: YAW DAMPER OFF ASE OFF

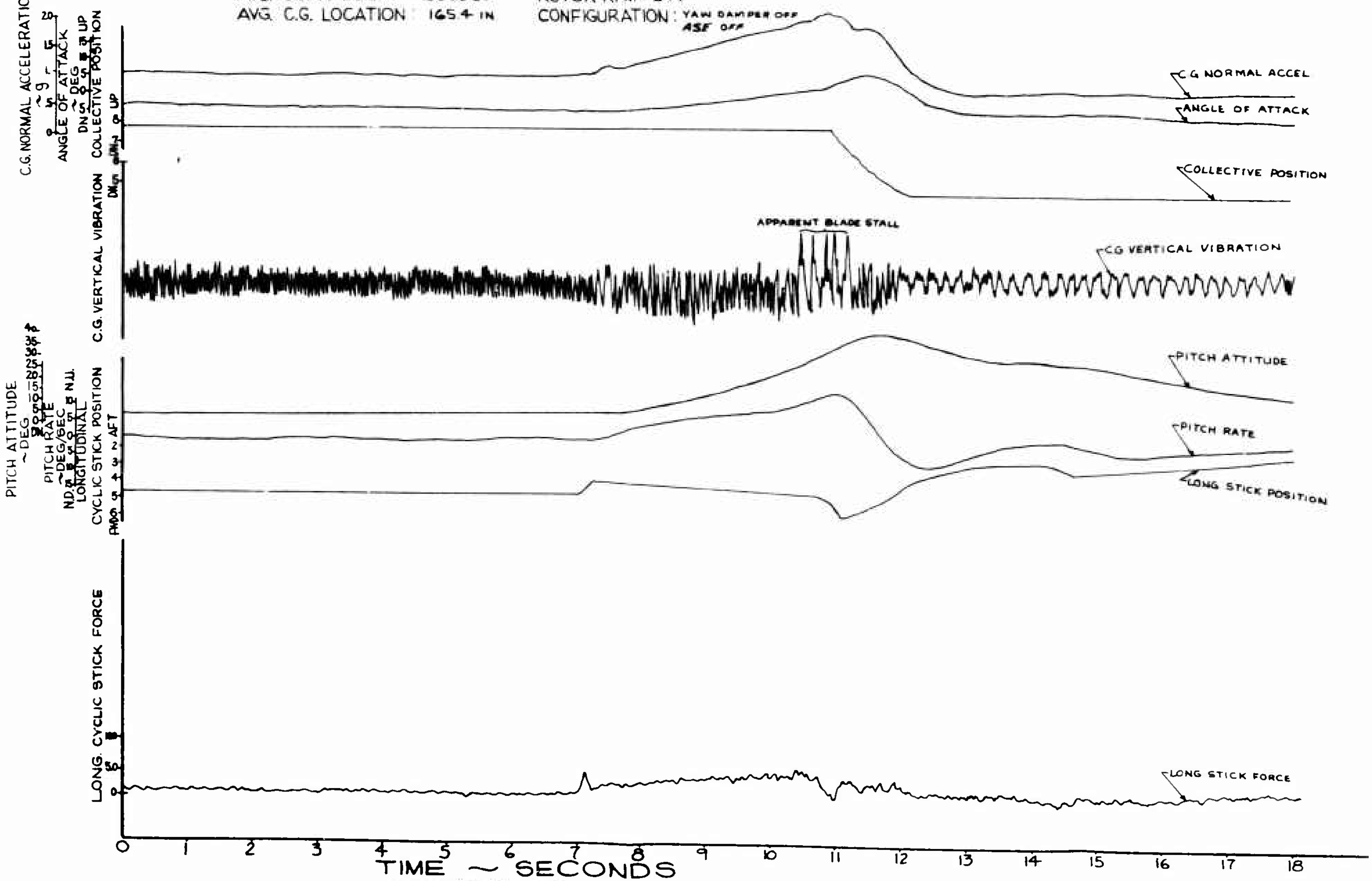

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FIGURE NO. 41

RELEASE FROM SIDESLIP

UH-2B 15-2202

AVG. DENSITY ALTITUDE: 2900 FT
AVG. GROSS WEIGHT: 9380 LB
AVG. C.G. LOCATION: 167.0 IN
AIRSPEED: 120 KTS CAS
ROTOR RPM: 277
CONFIGURATION: YAW DAMPER ON

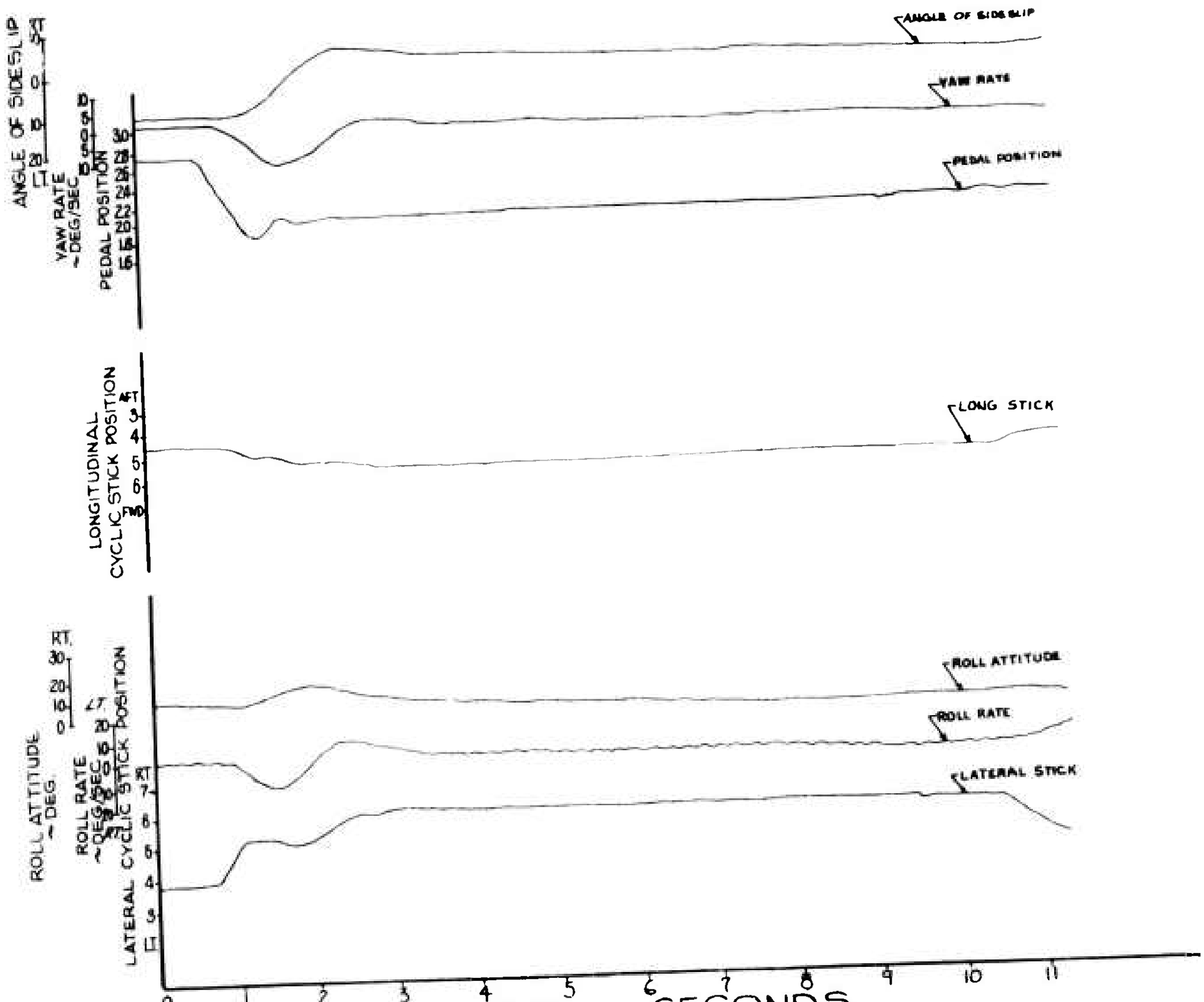

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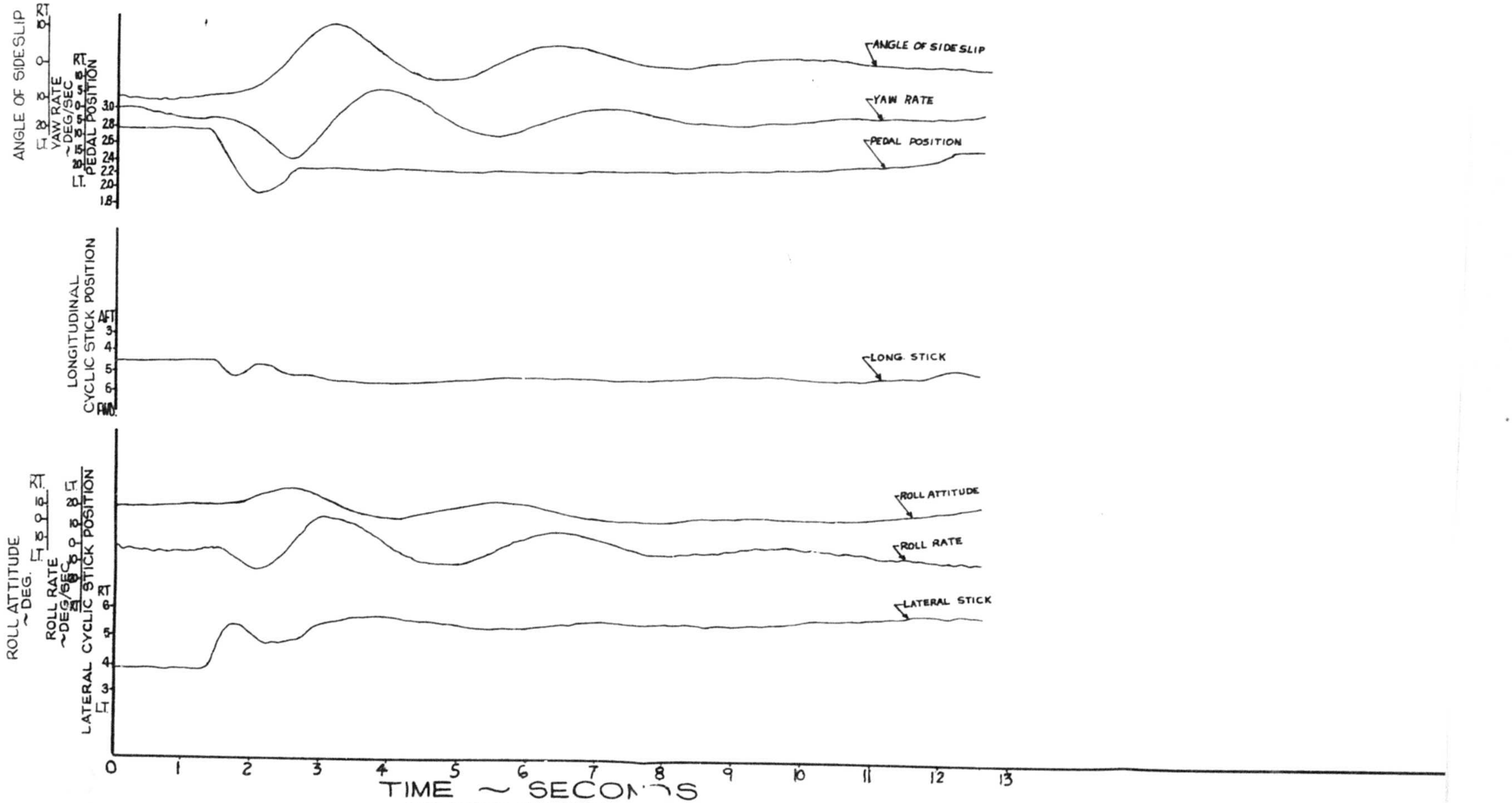
FIGURE NO. 45
RELEASE FROM SIDESLIP
UH-2B 15-2202

AVG. DENSITY ALTITUDE: 2900 FT. AIRSPEED: 120 KTS CAS
AVG. GROSS WEIGHT: 9380 LB. ROTOR RPM: 277
AVG. C.G. LOCATION: 167.0 IN. CONFIGURATION: YAW DAMPER OFF



APPENDIX II

REFERENCES

a. (C) Message 13923, AMCRD, Hq, U. S. Army Materiel Command (USAMC), 23 October 1965, subject: Expedited Flight Test Evaluation (U).

b. (C) Message 14297, AMCRD, Hq, USAMC, 28 October 1965, subject: Addition of UH-2 to Expedited Flight Test Evaluation (U).

c. (C) Plan of Test of Armed Helicopters (U), U. S. Army Aviation Test Activity, 28 October 1965.

d. (C) Report, "Early Engineering Confirmatory Flight Test Evaluation Improved Armed Helicopter," (U), Hq, USAMC, undated.

e. Military Specification MIL-H-8501A, "General Requirements for Helicopter Flying and Ground Handling Qualities," 7 September 1961.

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